THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

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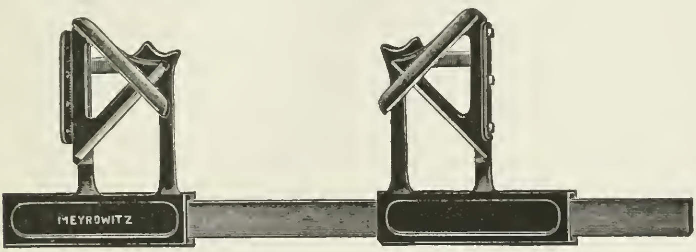
LIST OF LEADING SUBJECTS IN THIS VOLUME

Exophthalmometer. An instrument for measuring the degrees of exophthalmos in orbital tumor, Graves' disease, etc. Although the one best known is that of Hertel, yet there are several others in the market. For example, the instrument of Cohn is known by this name, although it was first called the ophthalmoprostatometer.

The apparatus designed by Lohmann (*Archiv f. Augenheilk.*, Vol. 75, p. 85) is said to be inexpensive and sufficiently exact. It aims to fulfill chiefly two requirements. 1. It does not annoy the patient and allows of reading in any position of the head. 2. The troublesome application and fixation by the observer during the examination is avoided. See page 4597 of this *Encyclopedia*.

Kiyosawa (*Ophthalmology*, Oct., 1914) has invented an exthalmometer on the principle of a pelvimeter. One arm is placed on the occipital protuberance, the other on the cornea. From the difference between the distances from the occiput to the right and left eye the degree of exophthalmus is calculated.



Hertel's Exophthalmometer.

The Hertel instrument has the advantage, according to the makers, that one person is enabled to measure the degree of exophthalmia rapidly and accurately. It is a convenient means of measuring the increase or diminution of the exophthalmia occuring in inflammations of the orbital cavity, in retrobulbar hemorrhage, with foreign bodies, in tumlor of the orbital and accessory cavities and more especially in exophthalmic goitre.

The working principle of the instrument will be readily gathered from the figure. It is fitted with two movable mirror and scale-carriers with sleeves, by which the former may be slid along a guide bar and accurately set to the outer margins of the orbital cavities of the patient's eyes. The distance between these margins is shown by the scale on the guide bar. Every time a fresh measurement is to be taken the instrument may be quickly set by the scale. The operator looks with both eyes into the left or right pair of crossed mirrors. The lower mirror shows the lower half of the vertical profile of the cornea

turned around into a plane at right angles to the observer's line of sight, whilst the upper mirror forms an image of the scale for measuring the protrusion of the cornea in approximately the same plane in which the profile of the cornea is seen; the two images are accordingly seen without any appreciable amount of stereoscopic parallax. In the event of the corneal apex being situated exactly 20 mm. nearer to the meridional plane than the points where the instrument rests on the orbital margins the plane of the scale image and that of the corneal profile are strictly coincident. The reading gives the distance in millimetres from a frontal plane passing through the points of application on the orbital margins.

Exophthalmos. Exophthalmos in general. Exophthalmus. Proptosis. Protrusion of the eyeball. Exophthalmia. The eyeball may project abnormally on account of many different causative factors, and although it is invariably but a symptom of some underlying condition, local or general, yet it is often the most serious symptom of that state and as such seems to deserve separate treatment.

Birch-Hirschfeld (Graefe-Saemisch *Handbuch der Ges. Aug.*, Vol. IX, 1907) gives the following classification of the causes of exopthalmos: A, *Protrusio bulbi;* divided into (*a*) encroachment on the orbital cavity and (*b*) diminished retraction, including paralysis of the third and seventh nerves. (*a*) is again subdivided into (1) deformity of the orbital walls and (2) increase of the orbital contents. B, *Protractio bulbi;* (*a*) due to increased protraction of the obliques, and (*b*) stimulation of the sympathetic system. Both subheads (*b*) may result from tenotomy of the recti and from muscular pareses.

Exophthalmos may be pronounced from deformity of the orbital walls, oxycephaly, "tower-skull," scaphocephaly and other congenital malformations. It is also, though rarely, seen in the orbital anomalies of rickets.

Ectasia of and deposits in the neighboring sinuses, foreign bodies in the orbit, hemorrhage, orbital cellulitis, orbital tumors and acromegaly are among other recognized causes of this symptom.

The most frequent accompaniment of exophthalmia is, however, exophthalmic goitre, which is separately treated in this *Encyclopedia.* Several forms of exophthalmos are also considered under separate headings.

Occasionally toxic agents, saponin and sulphur, for example, produce a more or less pronounced proptosis, not to mention the various forms of strangulation and suffocation.

Measurement of exophthalmos. As Rollet and Durand (*Revue Générale d'Ophtal.*, May, 1912) have pointed out there has been great

need of a precise instrument to demonstrate the degrees of exophthalmus. One is easily deceived by the position of the lids and the degree of prominence of the eyes, especially in Basedow's disease, where it would be most convenient to regulate the effects of the therapy. It is also most interesting in cases of orbital tumor, strabismus, errors of refraction and other diseases of the eye. The writers desired to prove by their results a coexistence of exophthalmus and atrophy of the optic nerve, also a connection in the diagnosis of nephritis, and likewise in the prognosis. There have been numerous models of an instrument for measuring. The Helmholtz model is exact, but cumbersome and very complicated. The use of the Javal ophthalmometer for this purpose needs a special arrangement, and this is not portable. The instruments of Cohn, Emmert, Kayser, Volkmann, Zehender and Birch-Hirschfeld fail, they say, because the eye is viewed from the side, and it is impossible to replace the contrivance in exactly the same position when the other eye is viewed. Other exophthalmometers are described and criticized. The most perfect apparatus seems to be the model of Hertel, the second of his two devices. It is not expensive, is compact and easily applied. However, these writers state that the apparatus is not precise, since different observers get a variance of 1 to 3 mm. in their measurements. The writers have modified the Hertel instrument by adding two sights on a scale, one fixed, the other sliding. Upon applying, the sights are moved to mark the tangent to the apex of the cornea and the exophthalmus read off on the modified scale. The great objection to this measure is that the orbital wall, upon which the principle is based, is not a fixed point, the same in every case, but as a whole about as near as we can come at present. See **Exophthalmometer.**

After measuring two hundred normal eyes the authors hold that the average protrusion is between 12 and 14 mm., and that following extractions the figures do not vary. Exophthalmus is greater than 14 mm., enophthalmus less than 12 mm. All hypermetropes scarcely reached the lower figure; cases of myopia varied more, but showed the larger figure. After strabismus tenotomies we find a rapidly decreasing exophthalmus. Glaucoma shows no change in the position of the eyes.

Atrophy of the nerve in nineteen of twenty cases had protrusion up to nineteen, especially unexplainable in tabies. Several cases of Basedow's disease were followed and decrease seen. In chronic nephritis 78 per cent. of cases examined had exophthalmus with bad prognosis.

Exophthalmos with general diseases. Cohen (*Amer. Jour. Med. Sc.*, CXLIV, p. 13) urges early diagnosis in exophthalmic goitre. In 15 to 20 per cent. of cases, surgery is made necessary by failure to

promptly institute non-surgical treatment; and in about 5 per cent. of cases surgical measures may become necessary, in spite of early skillful treatment. He advocates individualization. Both mental and physical rest, correction of errors of refraction, removal of all sources of reflex irritation, ice water coils over the heart and cervical spine, organotherapy and various forms of auxiliary medicine. Hoffmann (*Klin. Monatsbl. f. Augenh.*, May, 1912, p. 557) contends that cauterization of the normal nasal mucous membrane will cause disappearance of exophthalmus in Basedow's disease on the same side in twenty-four hours; due probably to a reflex influence on the unstriated muscular tissue of the orbit. Hack is cited who cured a case of Basedow's disease by cauterization of the inferior turbinated bone. In twenty-six cases of chronic interstitial, and two of chronic parenchymatous nephritis observed by Gardiner, fourteen presented exophthalmos of varying degrees, von Graefe and Stellwag signs, and seven the sign of Moebius. In five cases of exophthalmos with albuminuric retinitis, nephritis was present and in six cases arteriosclerotic changes in the retinal vessels. He gives as the probable explanation of exophthalmos and associated ocular signs in chronic nephritis, irrigation of the cervical sympathetic by toxins in the blood, the result of chronic renal insufficiency. Levison (*New York Med. Jour.*, Nov. 18, 1911, p. 1021) reported two cases of chronic nephritis with marked exophthalmos without marked lid symptoms. One case of unequal bilateral exophthalmos had optic neuritis. He says neither circulatory nor muscle theory explains all symptoms.

Unilateral exophthalmus in tumors of the brain, according to Uhthoff (*Ophthalmology,* July, 1913), speaks for a direct spreading or formation of metastases in the orbit, and is generally not accompanied by more intense ocular palsies. This is occasionally of great diagnostic importance in making a choice of certain surgical measures. Exophthalmus was observed in 3 per cent. of abscesses of the brain and 2 per cent. of the cerebellum.

Exophthalmus is most frequent in septic thrombosis of the sinus (70 per cent.) complicated with intense inflammatory symptoms of the orbit and septic thrombosis of the ophthalmic vein. Otogenous thrombosis of the sinus much more rarely leads to exophthalmus (9 per cent.), and always with involvement of the cavernous sinus.

Abstracts of important articles relating to the subject of exophthalmos in its various relations, not treated in the foregoing, have from time to time appeared in the *Ophthalmic Year-Book*. Some of these are quoted. To measure exophthalmos Fehr focuses the corneal image of the sound and the protruding eye with the telescope of the ophthal-

mometer. The degree of recession of the telescope required to give an exact image of each in turn, measures the protrusion of the eye. In Bertram's (*Arch. f. Augenh.*, LIX, 4, 1908) case of excessive congenital bilateral exophthalmos the section showed that forward pressure of the brain in consequence of precocious ossification of the sutures had narrowed the orbits. The brain pressed upon the excessively thin walls of the orbit like an intracranial growth, causing the proptosis. Chevallereau (*Soc. d'opht. de Paris*, March, 1908) reports a case of readily reducible exophthalmos provokable by slight efforts. The eye was small (H.8D); and had been tenotomized for convergent strabismus; probably an important factor in the production of the phenomenon. In Meissner's (*Wiener Med. Blätter*, No. 17, 1908) case exophthalmos with distinct pulsation occurred upon bending forward the head. The visual acuity was 6/6 with fundus normal; the probable cause was varix formation in the orbital veins. Beauvois (*Rec. d'opht.*, Feb., 1908) has observed in a new-born infant an exophthalmos from inflammation of the orbital tissues, transmitted from inflammation in the nose, which was probably caused by maxillary sinusitis. Anatomical studies show that the antrum although rudimentary at birth, may nevertheless be the seat of inflammation. In sudden exophthalmia of the new-born, careful examination of the nasal and buccal cavities should be instituted. The infection may be due to secretion from the parturient canal, or by contamination of the bath, or from the atmosphere. When the cause is recognized the treatment is usually quite simple.

In Lafon's (*Soc. française d'opht.*, 1908) case sudden exophthalmos occurred about 12 times in two years, the last followed by necrosis of the cornea. After enucleation a pseudo-tumor, due to degeneration of all the orbital tissues in consequence of repeated hemorrhages, was found. Johnson observed cure of exophthalmos follow removal of the anterior end of the middle turbinal, allowing drainage of the inflamed frontal sinus.

In Natanson's case, following the firing of a revolver close to the left ear, extensive exophthalmos and other grave symptoms of a post-bulbar growth, including optic neuritis, occurred. There were also symptoms of concussion of the labyrinth, pain in the distribution of the fifth nerve, tachycardia, goitre, and tremor. A course of mercury and iodide caused disappearance of almost all the symptoms. But as slight protrusion and distinct pulsation and some other symptoms persisted, a lesion of the carotid was suspected, the cause of which being supposed to be shock from firing the revolver. In a second case the same medical treatment brought about complete recession of an exophthalmos of the highest degree (almost luxation). The eyeball was

permanently displaced upwards, due perhaps to retraction by a cicatrix left by the gumma.

In the case reported by Foster there was excessive exophthalmos in which the seat of the disease was extremely obscure. A number of incisions were made into the orbit from some of which pus was obtained but these interventions were misleading as they appeared to indicate the nasal side and the accessory sinuses as the seat of the disease. Incision finally showed abscess of the zygomatic fossa that had entered the orbit through the spheno-maxillary fissure.

In Lustig's case one eye was blind and protruding, from a retro-bulbar sarcoma; and the vision of the other had begun to suffer from extension of the growth into the interior of the cranium. Severe cerebral symptoms were also present. Removal of the rather voluminous tumor together with the right eye was followed by rapid cure of the other eye and disappearance of the cerebral symptoms.

In their monograph on pulsating exophthalmos de Schweinitz and Holloway bring together and analyze 69 cases, which are presented in tabular form, along with 11 regarded as doubtful or atypical. They conclude that in view of the uniformly successful results in the 7 cases in which the superior ophthalmic vein was ligated that this procedure should be considered before ligation of a carotid. If a distended vein can be felt in the orbit they agree with Gifford that its ligation should be the operation of choice. Mackay (*Trans. Ophth. Soc. U. Kingdom*, Vol. XXVIII, 1908) reports a case of traumatic arterio-venous aneurism of the orbit treated by ligature of the common carotid artery with entirely satisfactory results. The exophthalmos and bruit disappeared, vision improved from counting fingers at 3½ meters to 6-18, and the paresis of the externus with convergent squint diminished.

In Demicheri's (*Ann. d'ocul.* Sept., 1908) case the pulsating exophthalmos was due to an intracranial hydatid cyst, puncture of which, with lavage, gave relief. Pooley's case of pulsating exophthalmos followed a severe blow upon the back of the head. Guibal's patient was a cavalryman who had been thrown, falling on his head. He was rendered unconscious and subsequently had severe cerebral symptoms. Exophthalmos appeared about the seventeenth day with pulsation, bruit, and interference with the orbital circulation.

In Parkinson's and Hosford's (*Ophth. Rev.*, May, 1908) case there was great proptosis of both eyes. Double neuro-retinitis was also present. The section showed a firm encapsulated growth, as large as a pigeon's egg, attached to the pia mater, on the under surface of the right lobe of the cerebellum. Königstein entered the orbit by Krön-

lein's operation for a supposed tumor. None was found, but the eye returned to its normal position.

Barker and Hanes (*Am. Jour. Med. Sc.*, p. 469, 1909) call attention to the frequent existence of exophthalmos and other ocular symptoms of exophthalmic goiter in connection with chronic nephritis. Of 33 cases of nephritis, 16 showed exophthalmos. All the fatal cases, 7 in number, and all the cases of albuminuric retinitis, 8, showed exophthalmos. Of these 16 cases 11 showed the von Graefe sign, 13 the Stellwag sign, and 7 Moebius' symptom of exophthalmic goiter. In 12 of the 16 cases the arterial tension was above 160 mm. They suggest that both in nephritis and in exophthalmic goiter these symptoms depend upon one or more toxins circulating in the blood.

In Harman's (*Trans. Ophth. Soc. United Kingdom*, p. 107, 1910) case there was extreme proptosis with divergence of the optic axes; the chin receded slightly, the lower lip protruded in front of the upper as is usual in oxycephaly. The head was entirely normal. In this case all the ocular and facial characteristics commonly associated with oxycephaly were present, without, however, any deformity of the skull cap, showing that the designation of these cases by the term oxycephaly or tower skull is incorrect. In Weinkauff's (Graefe's *Arch. f. Ophth.*, LXXIV, p. 352, 1910) case there was bilateral proptosis with immobility of the eyeball, edema of the bulbar conjunctiva, and optic neuritis with retinal hemorrhage. Pulsation and a loud murmur appeared, synchronous with the arterial pulse. The probable cause was believed to be perforation of arteriosclerotic foci in the wall of one or both internal carotids within the cavernous sinus. In Barbieri's (*Klin. Montasbl. f. Augenh.*, Feb., p. 244, 1910) case of bilateral exophthalmos, spontaneous rupture within the cavernous sinus of the internal carotid was regarded as the cause. Ligation of the common carotid first on one side and subsequently on the other, or still better, ligation of the common carotid was recommended. Richter (*Münch. med. Woch.*, LVII, p. 2767, 1910) reports a case of exophthalmos with severe orbital hemorrhage from a ruptured varix.

Wilder (*Ophth. Rec.*, pp. 195 and 327, April, 1910) saw a case of marked bilateral exophthalmos of five years' duration. There was beginning optic neuritis in each eye. The skiagram showed no bony growth. A large tumor mass not involving the muscle cone was removed from the left orbit via Krönlein's route as a result of which the condition of the left eye improved. Dollinger (*Zeitschr. f. Augenh.*, XXV, p. 359, 1910) has operated during the past ten years on thirty-nine cases of orbital affections which had caused exophthalmos; he first attempts to reach the seat of the disease from in front and only opens

the lateral wall of the orbit if this fails. In Risley's (*Ophth. Rec.*, XIX, p. 144, 1910) case, beside the proptosis, there was enlargement of the parotid gland with periostitis of the jaw and ramus. Three injections of 1 minim each of tuberculin were followed by entire disappearance of the symptoms. Cases of pulsating exophthalmos reported by Albertin and Desgouttes (*Recueil d'Opht.*, XXXII, p. 31, 1910) and by Schaefer (*Deutsche med. Woch.*, XXXVI, p. 124, 1910) were both cured by ligation of the common carotid. In the first case vision was lost by corneal opacity following infection from exposure. In the second, enucleation had failed to effect a cure. Van der Straeten (*Bull. de la Soc. Belge d'Opht.*, No. 29, p. 135, 1910) reports a case of doubtful etiology, but regarded as due to aneurism of the internal carotid. Bergin (*Guy's Hosp. Rep.*, LXIII, p. 245, 1910) reviews 300 cases of unilateral exophthalmos, and De Vaubercéy writes on unilateral ocular symptoms in exophthalmic goiter.

In Becker's (*Ophthalmology*, VII, p. 18, 1910) case there were proptosis of one eye with absolute fixation of the globe, slight edema of the upper lid which was almost immovable, slight chemosis of the conjunctiva, marked photophobia, and some lachrymation. Pupil dilated and immovable part of the time. The protrusion of the conjunctiva was due partly to hypertrophy, and the mass was removed. The urine showed very decided indican reaction. A strict dietetic and therapeutic regimen was instituted for the enterogenous decomposition: the final result being complete relief. In Fernandez' case the nose was filled with polypi which had proliferated into the orbit through a perforation in the floor, and also into the lachrymal sac giving rise to inflammation there. No improvement from operation on the maxillary sinus. Enucleation and finally death. Endothelioma was diagnosed histologically. Fry (*St. Barth. Hosp. Jour.*, XVIII, p. 40, 1910) reports two cases of intra-orbital aneurism.

Exophthalmos with rare orbital lesions. In Wray's (*Ophth. Soc. United Kingdom*, XXXII, p. 137) case of exostosis of orbit proptosis was very pronounced. Movements of the eye were free in all directions, and exophthalmos directed straight forward. The disk was atrophic with remnants of retinitis near the macula. Vision was reduced to light perception. A Kroenlein operation was performed showing an exostosis growing from the orbital surface of the great wing of the sphenoid. Sweet relates the subsequent history of a case of exostosis of the orbit. Tumors grew from the lateral plate of the ethmoid bone, and measured 41 by 25 mm. A discharging fistulous opening near the inner canthus was regarded as being due to lachrymal

disease. A radiograph showed frontal sinus involvement. Operation resulted in cure.

In Komoto's (*Klin. Monatsbl. f. Augenh.*, p. 500, April, 1912) case of lymphoma of the orbit the patient had exophthalmos. Extirpation of the eyeball showed a diffuse tumor pressing upon the eyeball from behind. The tumor consisted of single round cells, plasma cells and endothelial cells. Mention is made of another case of intraorbital lymphoma with inflammation of parotid, neck, and cubital and inguinal glands, without implication of the spleen or blood.

Dreisch (*Cent. f. p. Augenh.*, XXXV, p. 136) describes a case of leontiasis faciei with exophthalmos. The right upper and lower lids with surrounding tissue were greatly enlarged, and hung sack-like over the right cheek, including the eyeball which was about on a level with the right ala nasi. The optic nerve could be felt through the skin. Vision nil. Both upper and lower orbital margins were rough and uneven.

Sameh Bey reports a case of a boy of 14 years; attacked with chills, fever, vomiting, epistaxis, swelling of lids and protrusion of eyeballs. Sinuses were intact. Fundus changes resembled the first stage of choked disc. Evacuation of 50 gm. of pus, was followed by healing after eight days. V. = 1/2. In a second similar case vision remained impaired. A negress æt. 25, had swelling in the upper part of the orbit. The eye was crowded down; with diplopia. Vitreous cloudy, V. = 1/8. Evacuation of 40 gm. of pus gave, after three weeks, V. = 1/2. Another case was of a boy of 10 with swelling in upper inner region of the orbit. Vision was counting fingers at 2 mm. A few days later evacuation of 45 gm. of pus was followed by recovery.

Dupuy-Dutemps and Mawas (*Soc. d'Opht. de Paris,* Oct., 1913; *Clin. Opht.*, V. 19, p. 663) report three cases of cavernous angiomata of the orbit; while they had similar histological structures each case presented special interesting points. All three tumors were in the upper part of the orbit, strongly adherent to the bone and soft tissues. In the first case electrolytic treatment resulted disastrously, the eye being lost from hemorrhage. The second case presented repeated violent attacks of exophthalmos with subsequent return to the normal, after a few days, with ecchymosis. This was probably due to a hemorrhage into the cellular tissues of the orbit. In their third case, of a woman of 64 having exophthalmos, a tumor the size of an encapsulated nut was extirpated at the same time with a tumor of the mammary gland.

In zur Nedden's case of a boy of eight years, the right eye was injured by the handle of a rake applied with great force. At first

examination, a month later, there was a slight exophthalmos. There was no change in motility of the eyeball. Vision was normal. Two months later exophthalmos was enormous and interfered with motility. Firm resistance was felt on pressing back the eyeball. Pupillary reaction was very slow. Vision reduced to 1/10. A Krönlein operation revealed an infiltration of the retrobulbar tissues and a thickening of the lachrymal gland. Microscopic examination proved interstitial inflammation of the gland and retro-bulbar tissues. The Wassermann reaction was negative, but the von Pirquet test indicated tuberculosis. Rosenbach's tuberculin was injected with the result that exophthalmos receded and vision became normal.

Snell (*Trans. Amer. Ophth. Soc.*, Vol. 13, p. 496) reported a case of cavernous sinus thrombosis, occurring in a man of 24, previously in good health, from a small abscess in the skin of the temple. Twenty-four hours previous to his first visit he had noticed that the vision of the right eye was growing bad rapidly, and accompanied by rapidly swelling lids. The eyelids showed marked swelling; the conjunctiva was edematous, exophthalmos was pronounced and ocular movements were almost completely limited. The cornea was steamy and the pupil reacted to light sluggishly. On the fourth day a small ulcer made its appearance on the cornea and a slight hypopyon. Fundus examination showed swelling and edema of the disk, enlarged tortuous veins. The small temporal abscess was probed to the outer bony margin of the orbital brim, counter puncture made and it was washed out with bichlorid solution. Puncturing the orbital cavity deeply brought no pus. On the sixth day fluctuation was found in the upper lid and incised, a couple of drams of pus flowing out. For several days the patient was better but on the seventh day became delirious. After injecting a stock preparation of antistreptococcic serum the patient showed daily improvement for ten days while exophthalmos and limitation of motion continued. On the twenty-first day the pulse suddenly went bad, and on the twenty-third day he succumbed despite two more doses of the serum.

W. C. Posey (*Annals of Ophth.*, p. 663, July, 1912) exhibited a child with a mild degree of exophthalmos in both eyes, which doubtless was occasioned by shallow orbits, in whom the prominence of the globes had been greatly increased by the presence of adenoids, the proptosis recovering to its normal degree after the removal of the growths at the Children's Hospital. Posey said that literature contained many such, and cited cases reported by Holz, Spitler, and Hack. He also referred to a case reported by Batten, where the orbital involvement appeared after an attack of tonsillitis. Posey also pointed

out the connection which existed in a number of cases in the literature with Graves' disease, and referred in particular to a girl of 17 years reported by Hack, in whom the exophthalmos had existed since early childhood. Examination revealed a marked hyperplasia of the erectile tissue of the middle and lower turbinals. The lower turbinals were cauterized and the following day the exophthalmos had nearly disappeared. The Dalrymple sign and the Graefe sign which had been present disappeared. Also the nervous cardiac palpitation, and the size of the thyroid diminished; and a slight myopia, which had been present before the nasal operation, disappeared.

The exophthalmos had preceded all the other signs of Graves' disease for some years, and Hack thought that the excitation of certain portions of the peripheral sympathetic by the swollen tissues of the nose had occasioned the other symptoms, all being, according to him, of the nature of a reflex neurosis. He attributed the exophthalmos to hyperemia of the orbital vessels, caused by reflex dilation of their walls and to a marked turgescence of the retrobulbar fat, which he said Michel had already referred to as cavernous tissue. See, also, the headings under **Exophthalmic**; and the others beginning with **Exophthalmos.**

Exophthalmos anemicus. (Obs.) Exophthalmic goitre.

Exophthalmos cachecticus. An obsolete name for exophthalmic goitre.

Exophthalmos, Intermittent. In this rare condition the eyeball is protruded when the subject stoops or leans forward, and recedes within the orbit when he is erect or in the recumbent position; or the exophthalmos may be voluntarily produced by the act of blowing. Posey reports a case in which a young adult could in this manner voluntarily proptose the left eyeball fifteen millimetres in advance of its fellow. The cause is presumably some varicose condition of the veins of the orbit. These veins are not in communication with an artery, which differentiates the condition from pulsating exophthalmos (Fuchs). Weeks has observed two cases due to posterior ethmoiditis in which the escape of secretions was temporarily interfered with. The ethmoidal cells affected passed directly under the floor of the orbit posteriorly.—(J. M. B.)

A careful analysis of a case is reported by Birch-Hirschfeld and Romeick (*Klin. Monatsbl. f. Augenheilk.*, Apr., 1912). It was caused by a retrobulbar varix which, in stooping had produced by venous stasis an exophthalmus of 2.50 mm.; if this position were prolonged it was increased to 6 mm. The etiologic element in the retrobulbar stasis was attributed to abnormal narrowness of the anterior efferent paths. viz., the facial and jugular veins, perhaps by pressure of a retrosternal

goitre. The writers believe that not every case of intermittent exophthalmus ought to be operated on, on account of the danger to the optic nerve and the posterior ciliary vessels, if the varix lies very deep.

In Loewenstein's (*Klin. Monatsbl. f. Augenh.*, p. 183, Aug., 1911) case (a primipara three weeks after confinement) there was noticed after having bent over, a tumor of the left lower lid and protrusion of the eyeball, recurring after every greater physical effort. V. = 0. Extirpation of convoluted veins, through an incision in the lower lid along the lower orbital margin was made and secured vision of 0.1.

Colombo (*Ann. di Ott.*, Vol. 42, p. 602) reports a case of intermittent exophthalmos in a girl of twelve years, who had been affected for two years with a right suppurative otitis media. The parents stated that one night three months earlier, the child had waked from sleep with a severe pain in the right eye, which was followed by a marked exophthalmos of short duration. The child was brought on account of a second attack of the same nature, also occurring in the night. Trauma was denied. There was ptosis of the right upper lid. The eye was exophthalmic 1.5 cm.; and the movements of the bulb were limited in all directions. There was no pulsation, and the exophthalmos was not reducible by pressure. The ear condition was treated and the exophthalmos disappeared. The mother later reported two relapses of the exophthalmos, the first lasting a half hour, and the second lasting ten minutes. The eye was found to be normally slightly enophthalmic. It became exophthalmic if the child stood and inclined her head forward and downward for several minutes, or if she lay for several seconds on her face; or in the erect position on compression of the right jugular; or if the head was kept turned to the right. The otitis media had completely healed and Colombo attributes the exophthalmos to varices in the back of the orbit. See, also, **Exophthalmos.**

Exophthalmos paralyticus. (L.) Exophthalmia resulting from total or partial paralysis of the oculo-motor or other muscles of the eye.

Exophthalmos, Pulsating. ANEURYSMAL PROPTOSIS. VASCULAR PROTRUSION OF THE EYE. This formidable lesion is comparatively rare, although more than 300 cases are now on record. A complete analysis of 69 case histories has been made by de Schweinitz and Holloway (1908), to which the reader is referred for a more detailed account. In typical cases the condition is characterized by protrusion of the eyeball; noises or bruit to be heard at the entrance of the orbit, or by auscultation over various points of the skull, even over the occiput; and by pulsation near the orbital apex transmitted through the eyeball.

The exophthalmos, if unilateral, or if more pronounced on one side than on the other, gives rise to diplopia. The bruit is both a subjective and an objective symptom. It is increased by lying down or stooping, or by any exertion raising the blood-pressure. The noises in the head are incessant and cause much distress. They stop or are greatly modified when the blood-supply to the side of the head affected is interrupted by compression of the common carotid artery. The pulsation—generally demonstrable by careful palpation—is sometimes visible. The veins of the lids, of the conjunctiva, and of the retina are often distended and tortuous—the result of passive hyperemia. In a certain number of cases optic neuritis, optic-nerve atrophy, retinal hemorrhages, glaucoma, and cataract have been noted. More frequent than these last-named symptoms is paralysis of the abducens nerve. Vision may remain intact throughout the entire course, but it is more frequently impaired, and often complete blindness results (de Schweinitz and Holloway).

Exophthalmos with pulsation may be due to a variety of lesions, both intra-orbital and extra-orbital. Thus, it may be a symptom of extremely vascular tumors within the orbit, due to a true aneurism of the ophthalmic artery in its intra-orbital or intra-cranial portion, aneurism of the internal carotid artery, arterio-venous communication, varicose dilation of the orbital veins, or communication between the internal carotid artery and the cavernous sinus. The last-named condition has been found to be the most frequent cause. Thus, the disease in the majority of cases is of intracranial origin, the protrusion of the eyeball and the other orbital symptoms being secondary and dependent upon venous obstruction. Rivington demonstrated the intracranial origin of pulsating exophthalmos, which was a distinct advance in the pathology of this condition. In an analysis of 19 autopsies Frost found orbital aneurism in 3, affection of the cavernous sinus in 2, aneurism of the intra-orbital portion of the ophthalmic artery in 2, arterio-venous communication in 8, and the condition undetermined in 4.

With arterio-venous or arterio-sinus communication we have obstruction of the venous outflow of blood, which induces marked distension and varicosity of the veins. The blood-current then becomes reversed, and the distended veins carry arterial blood (Sattler). At this stage pulsation commences. As more or less time is required for these changes to take place, and as, indeed, they may not take place, pulsation may not appear early nor need it occur at all.—(J. M. B.)

For further remarks on the etiology, pathology, diagnosis, and prognosis of this disease, see **Exophthalmos, Traumatic.**

Treatment. Although the most rational procedure in the conduct of these cases is ligature of the common carotid yet de Schweinitz believes that digital compression of that vessel, with or without the employment of full doses of potassium iodide, injections of gelatin, doses of coagulose, etc., may first be tried. Spontaneous cure rarely occurs. If ligation of one carotid fails the other may be tied or, if there be a distended ophthalmic vein (or other orbital vein), it should be dissected out.

The various forms of operative and other treatment will be further considered in the subjoined abstracts of papers and monographs. See, also, **Exophthalmos.**

Beatson Hird gives the following review of an interesting case-report in which he remarks that pulsating exophthalmos is a distressing condition on account of the continuous noises in the head, and it is imperative to relieve this symptom if possible. The operation of ligation of the common and internal carotid arteries is very serious and sometimes fatal. Further, it fails in a large number of cases to produce any but a temporary relief. Several cases have now been recorded of successful cures by ligation of the orbital veins, an operation of little gravity.

Buchtel (*Ophthalmic Record,* Feb., 1913) reports a case in which cure was brought about by such an operation. His case was that of a boy, aged 11, the pulsating exophthalmos being due to a blow on the head by a pitchfork: "The operation is very simple, merely distal ligation of the veins in the orbit and the mortality should be almost nil. The eyebrow was shaved and general anesthesia used. An incision in the eyebrow, two inches long, was made from a point near the middle line. The skin flaps were turned up and down. Many dilated superficial veins were cut which required ligature. The angular vein and superficial temporal were both dilated and cut. The superior ophthalmic formed by the junction of the two radicals above-named was followed into the orbit back as far as possible without damage to the eyeball and ligated with plain cat-gut. A subcuticular stitch of plain cat-gut brought the skin surfaces together."

After this the bruit was absent. Following the operation considerable edema of the eyeball developed as well as edema of the conjunctiva. The patient was kept in bed a week and the eye kept cleansed and argyrol instilled. The exophthalmos was a little greater than before the operation at first, but this together with the edema of the conjunctiva gradually subsided until after three months there was practically no difference between the two eyes. The vision was normal with no diplopia or change in the eye. The scar was concealed by the eyebrow. The bruit was permanently cured.

R. Kaz (*Ophthal. Review*, Aug., 1912) gives a review of Orloff's paper, based on a case of pulsating exophthalmos that developed six months after a deep wound in the region of the left parietal and temporal bones in a thirty-year-old patient. A successful result followed ligature of the ophthalmic vein in the depths of the orbit after a temporary resection of the external wall of the latter. This operation, first performed in 1881 for cases arising spontaneously by Noyes, and in 1897 by Golovin for traumatic ones has proved successful even after failure of ligature of the carotid. The author has collected 36 published cases of one-sided ligature of the carotid for traumatic pulsating exophthalmus between the years 1898 and 1909 with only ten complete cures. Of the remaining cases 14 showed some improvement, in 8 temporary improvement was soon followed by a relapse and in the remaining 3 the operation proved fatal. Including his own case he can only find five cases recorded in which the ophthalmic vein was ligatured, but these were all successful. He has also found recorded three cases in which non-surgical treatment by the injection of gelatine proved efficacious; Lebon, 1902, Santos-Fernandez, 1907, and Beauvois, 1907. In Lebon's case this treatment was adopted after ligature of the carotid had proved a failure. The author concludes that in these cases trial should be made of gelatine injections first and, if these fail, of ligature of the ophthalmic vein, ligature of the carotid being reserved for those cases in which cerebral symptoms prevail.

A number of recent abstracts from the *Ophthalmic Year-Book* also throw much light on this important subject.

In Lystad's (*Klin. Monatsbl. f. Augenh.*, p. 88, Jan., 1912) case of pulsating exophthalmos the internal carotid was ligated. But this not being sufficient, the external carotid and jugular vein were also ligated. The result at first was good, but as exophthalmus and pulsation returned the pulsating orbital veins were ligated, followed by enormous protrusion of the eyeball which gradually diminished, but ended in absolute glaucoma and the eye was enucleated. Lystad assumed a communication between the internal carotid and cavernous sinus. Wolff (*Arch. of Ophth.*, XLI, p. 514) reports the case of a man of 54 having irregular attacks of chemosis and exophthalmos of 1 cm., lasting three or four days. The eye had the appearance of an orbital phlegmon without inflammatory symptoms. No nasal discharge.

Friedenwald (*Amer. Jour. Ophth.*, XXVIII, p. 131) reported a case of pulsating exophthalmos without bruit, in a woman of 20 who had pain in her right eye and said it bulged out of its socket for eleven or twelve years. The right eye was very prominent and displaced down and forward and pulsated markedly. It was about 12 mm.

lower than the left, and forced forward at least 5 to 6 mm. with each pulsation; but could be easily pushed into the orbit without discomfort. Vision, L., 16/15; R., 16/200; field of vision normal, diplopia; no congestion or tortuosity of blood vessels. Nose examination revealed a distended bulla ethmoidalis. In Wilder's (*Amer. Ophth. Soc.*, XII, p. 832) two cases of pulsating exophthalmos, both were due to blows upon the head. Exophthalmos was marked, but pulsation slight. In case one, ligation of the common carotid resulted in permanent cure. In case two, ligation of common carotid gave relief from bruit and head noises, but exophthalmos did not recede completely until the internal carotid was ligated.

Knapp's case of spontaneous bilateral exophthalmos, began with headaches and head noises, congestion of cutaneous veins, eyelids and conjunctival vessels. Paralysis of both external recti and loss of sensation of both corneas. Bruits were heard in front, and to the temporal sides of both orbits. Wassermann positive. After inunctions and gray pills the right eye returned to its normal position and the left eye remained somewhat prominent.

Mathewson reports a case of a man of 32 who was thrown from the top of a car and sustained a fracture of the base of the skull, resulting four weeks later in exophthalmos, complete ptosis of the left upper lid, swelling of the conjunctiva and subsequent loss of vision, probably due to laceration of the optic nerve, resulting from basal fracture. The movements of the eyeball were restricted; a loud, blowing murmur was heard most intense over temporal region. After ligating the common carotid artery, proptosis became less, pulsation and bruit disappeared.

Balbuena reports a case of a man of 25 years who was shot in the middle of the forehead. Some days later he noticed loss of vision, protrusion of the eye and lids of the left eye. The proptosed eye had pulsated synchronously with the radial pulse. He had a marked bruit, very distinctly heard at the upper inner angle of the orbit. The optic disc was atrophic. The condition of the eye was diagnosed as an aneurysm located in the orbital vessels, anterior to the sphenoidal fissure. Twenty-one subcutaneous injections of 4 per cent. gelatin were made without improvement while six intravenous injections of the serum were given at intervals of eight to ten days, effecting a cure.

Feruglio (*Ann. di Ott.*, Vol. 42, p. 287) emphasizes the value of a centrifugal venous pulse in establishing the diagnosis of arterio-venous aneurysm in a case of exophthalmos. The exophthalmos was caused by an injury at the internal third of the left lower lid causing effusion of blood in the subcutaneous tissue and conjunctiva, vomiting, cephalalgia and marked change in character. The hemorrhages were absorbed

but the exophthalmos showed no tendency to disappear. Vision was normal but the cerebral symptoms recurred. Ophthalmoscopic examination showed slight hyperemia and edematous conditions of the vessels; systolic pulsation of the veins synchronous with the arterial pulse. The bulb could be easily pushed back into the orbit pulsating with the radial artery. A loud murmur was heard with the stethoscope over the closed lids and cranial bones. Ligation of the left common carotid was performed resulting in great reduction of the exophthalmos and restoration of movements. Fifteen days later the patient returned with recurrence of former symptoms. The right common carotid was ligated without favorable results. A Krönlein operation was advised but not accepted.

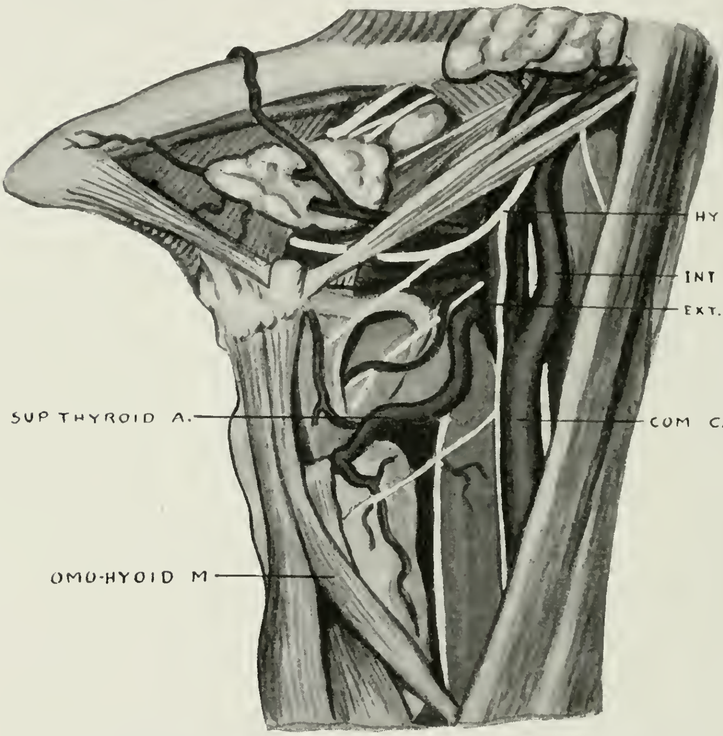
As has been seen, the *chief operative measures* that have been employed in the treatment of pulsating exophthalmus are, (1) ligation of the common carotid on the affected sides, (2) ligation of both common carotids; (3) ligation of the internal carotid on the affected side; (4) ligation of both internal and external carotids on the same side; (5) ligation of the common external carotid and superior thyroid arteries on one side; (6) orbital operations, as (a) ligation of superior ophthalmic vein; (b) ligation of pulsating veins at the inner angle of the orbit with excision of the varices that are a common accompaniment of this condition.

In a case operated on by the writer at the St. Luke's Hospital, October 14, 1909 (*Surgery, Gynecology and Obstetrics*, Jan., 1910, p. 55), the internal carotid alone was ligated. Immediate cessation of the pulsation and bruit, with later retraction of the eyeball, followed. There were no untoward after-effects and the patient has been free from both objective and subjective symptoms up to the present time.

The relief from pulsating exophthalmus by *orbital operations* alone can only be accomplished in those cases in which the altered tissues lie within the orbit, or in cases where an aneurysm of the carotid, by pressure upon the ophthalmic vein, is the cause of this condition. Where there is an aneurysmal varix, which constitutes the essential cause in about 70 per cent. of the cases, no intra-orbital operation alone will relieve the patient.

One of the chief symptoms is pulsation with dilatation of the ophthalmic vein. When this results from pressure upon the vein by an aneurysm of the carotid, ligation of the vein just before it enters the sphenoidal fissure may relieve the objective symptoms of pulsation and exophthalmus, but cannot remove the subjective symptoms occasioned by the aneurysm, nor cure the disease. In the cases treated by ligation of the angular vein and of the ophthalmic vein, by Noyes (*Trans. Am.*

Ophth. Soc., Vol. III, pt. 2, 1881, p. 308), we must assume, in the absence of any anatomical data, that the symptoms were not the effect of an arterio-venous aneurysm involving the carotid and the cavernous sinus. In Noyes' case his description fits more accurately an arterio-venous angioma involving the ophthalmic artery and vein than it does an arterio-venous aneurysm of the carotid. His success in curing the dis-



The Relations of the Common, External and Internal Carotids to the superior thyroid and other neighboring structures.

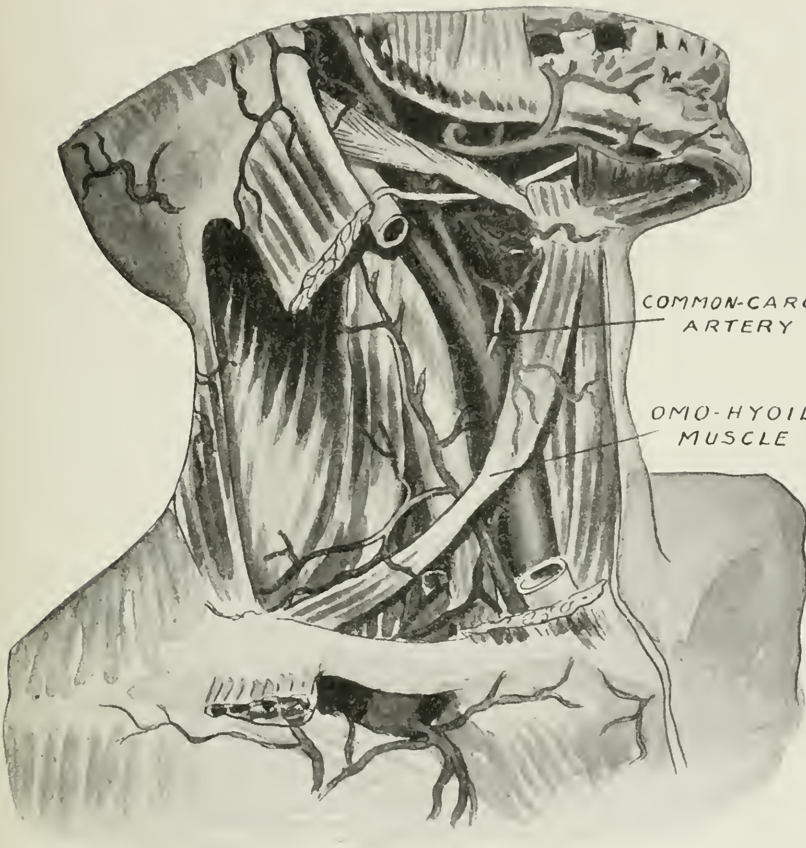
ease by ligation and excision of the pulsating dilated vessels of the orbit he attributes to a thrombus forming and extending back to the sinus, closing the opening into the aneurysmal sac.

These operations on orbital vessels have been successful in the hands of others, both as primary operations and as secondary, and performed either at the time of the ligation of the carotid or subsequent to it, in cases where the ligation of the carotid did not immediately effect a cure.

In a case reported by Boden (*Deutsch. Arch. f. Klin. Chir.*, Bd. 51,

p. 605), five months after bilateral ligation of the carotid the ophthalmic vein was ligated with success.

In the cases where the symptoms are the result of an aneurysm of the ophthalmic artery, it goes without saying that proximal ligation

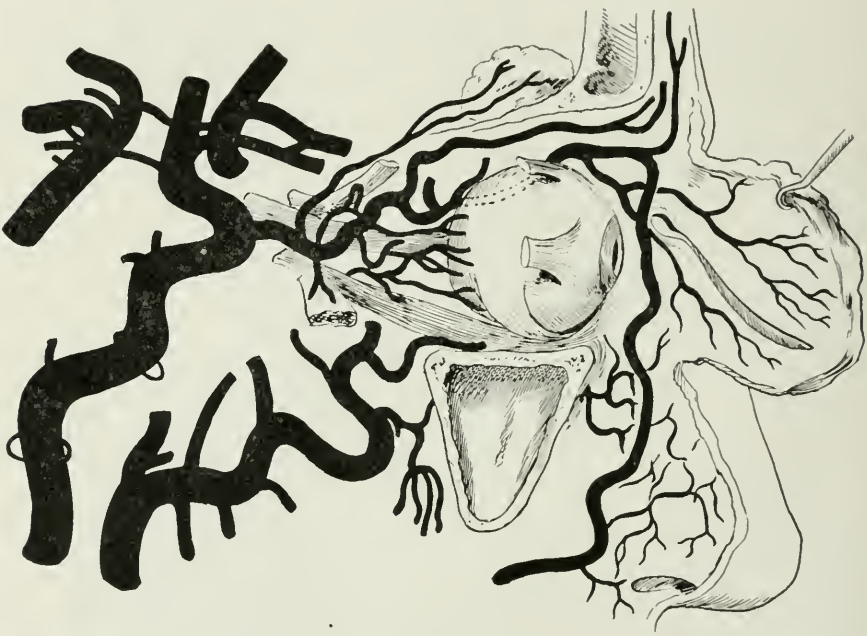


Dissection showing the Relations of the Common Carotid to the Omo-hyoid muscle.

of the artery, if this operation can be successfully performed, will give the best results. Distal ligation, when the proximal operation is not possible, will in a relatively small proportion of the cases prove successful.

Technic of ligation of the common carotid. The seat of election for the common carotid is above the omo-hyoid muscle. The patient is placed upon the table with the head and shoulders elevated by means

of a pillow placed between the shoulders. The chin is drawn up and turned away from the seat of operation. An incision, three and one-half inches in length, is made with the center corresponding to the cricoid cartilage, along the anterior border of the sterno-mastoid muscle. This extends through the skin, platysma and the deep fascia, enclosing the sterno-mastoid muscle. The superficial veins, including the external jugular, are caught before being incised and then divided



Relations of the Carotid Arteries and Jugular Veins to the Ocular region.

and ligatures applied. When the fascia enclosing the sterno-mastoid is reached, it is grasped with a Kocher forceps and pulled forward. It is then incised in the direction of the skin incision, though not to the same extent. The sterno-mastoid is retracted slightly outwards and the omo-hyoid downwards, exposing the internal jugular with the descending branch of the ninth nerve. The sheath of the fascia enclosing the vessel is now opened and the jugular vein drawn outwards from the artery. The artery is freed from the surrounding structures by a Kocher director, armed with a catgut ligature, passed underneath the artery from without inwards, the ligature secured and the director withdrawn. Two ligatures are thus passed about the vessel and tied, one centimeter apart. The ligatures are tied tight enough to occlude

the lumen. No effort is made to crush the vessel wall. If thought desirable, the vessel may by means of an artery forceps be crushed between the ligatures or divided. This last act is unnecessary. The structures that must be avoided are the internal jugular vein, the pneumogastric and descendens hypoglossi nerves.

The wound is closed by reuniting the fascia over the vessels with a fine catgut suture and the skin by silkworm gut. The wound is dressed in the way we have described and the patient placed in bed with the head elevated.

Ligation of the internal carotid. An incision is made so that both internal and external carotids are exposed just above the bifurcation of the common carotid. This extends along the anterior border of the sterno-mastoid from the angle of the jaw to the middle of the neck, the center corresponding to a point on a level with the upper border of the thyroid cartilage. The vessels are exposed by drawing the sterno-mastoid outwards and the digastric muscle upwards. The external carotid should be drawn inwards, as in this part the internal carotid lies outside and rather behind the external. The ligature is passed on a Kocher's director from without inwards, avoiding the internal jugular vein and the pneumogastric nerve.

The external carotid may be ligated through the same incision, and in the same manner as the internal carotid.—(A. E. H.) See, also, **Exophthalmos, Traumatic.**

Exophthalmos simplex. (L.) Of the older authors, that form of exophthalmia, the cause of which is unknown.

Exophthalmos, Traumatic. Traumatic exophthalmos occurs from several forms of injury to the eyeball or its adnexa. Protrusion of the eye occurs from bleeding into the orbit and from movement forward of bone fragments. Here we deal with pulsating exophthalmos, which in 71 per cent. of the cases is due to traumatism.

The first technical description of this lesion was given by Travers in 1809; the first anatomic examination was made by Barron in 1835. Since then many cases have been reported by other authors. It is found most often (75 per cent.) in men between thirty and fifty years of age, i. e., in the most active working period of life when most commonly exposed to severe exertion and accidents. The so-called spontaneous form is more common in women.

This affection may be due to an arterio-venous aneurysm of the internal carotid and the sinus cavernosus, aneurysm of the ophthalmic artery, anginous, and other kinds of tumors, especially sarcoma and encephalocele, in all of which the exciting cause of the protrusion may be a traumatism, but in most cases it is due to a rupture of the internal

carotid artery in the sinus cavernosus, by which the arterial stream passes directly into the veins, which fill with blood and push the eye outwards. The blood from the ophthalmic veins is not then carried back into the circulation properly on account of the pressure of the carotid in the sinus being more than in the veins, so the vein becomes practically an artery and forms a pulsating tumor above and to the inner side. From this condition of pressure all the clinical symptoms arise. In cases not due to rupture, such as aneurysm of the carotid or ophthalmic arteries, the conditions are somewhat different and due to direct pressure. The lesion, in most cases, is situated in the cranium and not in the orbit. The superior thyroid artery plays an important

Traumatic Pulsating Exophthalmos.

part in the compensatory circulation after tying of the common carotid, when it is found dilated and strongly pulsating.

Soon after, but usually not immediately upon, receipt of the traumatism, usually a few hours or days, sometimes weeks or months afterwards, the patient has a violent pain in the eye, the lids become reddened and swollen, the veins full, the upper lid is especially swollen and immovable and cannot be raised, sometimes on account of its weight and sometimes on account of paralysis. The under lid becomes swollen, the conjunctiva chemotic, the eyeball protrudes strongly, usually outwards and downwards, and is generally immovable so that double images occur. An even pressure upon the globe may force it back into position, but it soon returns. Bending over increases the symptoms. Pulsation of the eyeball, synchronous with the radial pulse, is then apparent, and is heard, upon auscultation over the eyeball in the region of the orbit and even the neck, as an aneurysmal murmur which, as a rule, the patient himself hears.

In true rupture of the carotid in the sinus the bruit is increased in systole. On pressure on the common carotid in the neck the symptoms disappear. As a rule the condition appears only upon one side and then later on the other. The conjunctiva of the eyeball becomes chemosed, its blood vessels enlarged, and the tension increases.

The lid aperture becomes enlarged, no longer fully protecting the cornea, and when the lids cannot be closed the cornea becomes dry and ulcerated. Foreign bodies may become impacted without notice, as in most cases the sensitiveness is lost. The anterior chamber becomes deeper, the iris discolored, the pupil moderately enlarged and immovable. The vitreous becomes turbid and papillitis develops. The veins enlarge, the arteries diminish in size. Capillary hyperemia follows later. Atrophy of the optic nerve occurs when the canalis opticus is injured. The sight depends upon the condition of the media and the implication of the optic nerve. It may be normal or greatly diminished, even where there is high degree of papillitis, as in choked disc, the sight may remain good. From the pressure behind, the eye becomes shorter and hyperopia develops. The accommodation is usually diminished. In old cases the sight is lost through disease of the uvea and increased ocular pressure proceeding to degenerative changes, or through ulceration of the cornea.

The subjective symptoms at first are pains in the head and orbit, vertigo, feeling of pressure, blowing, ringing, and knocking sounds in the head. The patient is generally uncomfortable, although in but few cases does the pressure extend sufficiently to the brain to cause changes therein.

The clinical picture fully explains the conditions of communication of the carotid with the sinus. The symptoms, as a rule, do not occur immediately upon receipt of the injury, but somewhat later. As but little blood at first passes from the carotid, the ophthalmic veins become more filled through the collateral circulation. Later inflammatory changes set in and then the arteries become atrophic. The blood now flows from the carotid through the cavernous sinus into the veins of the eye and lids, which accounts for the synchronous pulsation, and the picture of venous stasis of the retina. Through the impact of the arterial pressure on the veins come the noises which are apparent at the time of systole, produced by irregular pressure on the carotid artery in the sinus. Immovability of the eye outwards occurs from paralysis of the abducens nerve, which passes by the cavernous sinus. From this cause likewise, occurs paralysis of the oculomotor, trochlear, and the first twig of the trigeminus.

From the immovability of the eye and the wideness of the lid aperture the cornea may get dry and become the seat of infection and ulceration. The paralysis is caused from the first twig of the trigeminus. In many cases there are anomalies of hearing.

In a few cases all symptoms cease or ultimately disappear after a year or two. Death may be due to the breaking of the bones of the skull, and involvement of the brain from bleeding or infection. Inflammation of the mediastinum may occur from thrombosis in the sinus. When such complications do not occur the pulsating exophthalmus may become less and sight better, but as a rule the subjective symptoms remain.

The diagnosis is made from the cardinal symptoms, the proptosis, pulsation, objective and subjective noises, and vertigo. It should be differentiated from proptosis due to Graves' disease and tumors, cellulitis and orbital phlegmon, ethmoidal mucocele, rachitic deformity of the skull, osteoporosis. The differential diagnosis from rupture of the carotid or aneurysm of the ophthalmic arteries may be made, as in rupture of the carotid there is paralysis of the nerves, especially of the abducens, and in aneurysm of the ophthalmic artery the vision is much affected on account of the lesion being in the orbit.

The prognosis is not so bad. In 80 cases only 9 died; 11 per cent. The carotid walls seem to heal in about half the cases, either through natural means, through pressure, or the result of operation. Where pulsating exophthalmus depends upon fracture of the skull the prognosis is not good.

In a series of 113 cases of ligature operations only 10 died, 3 from infection (all before 1880), 2 from hemorrhage, 1 from changes in the blood vessels, 1 from anemia and 1 from general debility.

The therapy is either by pressure upon the carotid, by the fingers or instruments, or by operative procedures. Only a few cases are relieved by compression, in most of which it has been of short duration, necessitating frequent repetition during the day. Of seven cases not treated, two became better, two grew worse, and three died, one of the deaths occurring from hemorrhage after operation for a supposedly malignant tumor. Of thirty-seven cases treated by compression there was a complete cure in three cases, an incomplete cure in six, and sudden death in one case, while there was not any result in the remainder.

When compression does not lead to a cure the radical operation of tying the common carotid in the neck has cured a large number of cases, the general mortality being not over 10 per cent. The cures by this operation are about 50 per cent. There are six cases in all recorded of tying of both common carotids.

In every case the operative treatment of pulsating exophthalmus must be individualized according to the clinical form of the affection. In those cases where marked brain symptoms are present, as, for instance, vertigo, distressing subjective noises, etc., one must by all means ligate the common carotid. In those cases where the clinical symptoms are confined to either the orbit alone or to the orbit and face together, it is better to perform an orbital operation. It is probable that in some cases one would get a good result by ligating the ophthalmic vein, making the incision under the eyebrows. The ligation of the ophthalmic vein with a previous resection of the orbital wall (Kroenlein) will be found generally useful in those cases where relapses have occurred or where ligation of the carotid has failed. In such cases, indeed, this operation should be given the preference to ligating the common carotid of the opposite side since this latter is apt to excite too great disturbance of the cerebral circulation. Resection of the orbital wall must be performed whenever the clinical picture of the pulsating exophthalmus suggests the possibility of an intraorbital growth.

The aneurysmatic varix may be first ligated. Since the ectatic vessels almost always lie near the medial wall, they can be easier and less dangerously approached through the upper lid than by Kroenlein's resection of the lateral orbital walls.—(H. V. W.) See, also, **Exophthalmos in general**; as well as **Exophthalmos, Pulsating.** Under the latter caption will be found a description of the operations employed for the relief of pulsating exophthalmos.

Exophthalmos, Unilateral. Uhthoff (*Klin. Monatsbl. für Augenheilk.*, p. 401, Oct., 1912) found that unilateral exophthalmos, without involvement of the orbit (the common source of a one-sided exophthalmos) was in 11 cases on the side of the tumor of the brain that produced the proptosis and in 4 cases of bilateral exophthalmos more intense on that side.

Exophthalmos, Voluntary. Proptosis can occasionally be induced at will. A classic example is that of the man, aged 19, who consulted Barrière (*Klin. Monatsbl. f. Augenheilk.*, March, 1912) on account of exophthalmos of the right eye, and complained of diplopia during mastication. The exophthalmos (5 mm.) had existed from the first years of his life and gradually progressed. When the patient pressed the jaws forcibly together, increase of exophthalmos of 2.5 mm., homonymous diplopia in the right half of the field of fixation and tumor-like bulging in the temporal half of the lower lid and external canthus were all noticed. A tumor of the size of a hazelnut was felt in the lower temporal portion of the orbit, which could not be pressed back

into the orbit. On relaxation of the masticatory muscles the tumor and diplopia completely disappeared. A puncture showed that it was a dermoid cyst extending through the inferior orbital fissures into the temporal fossa. It was extirpated by Krönlein's operation.

The phenomena during mastication found the following explanation: The fluid contents of the portion of the cyst lying in the temporal fossa were by the contraction of the temporal muscle forced into the orbital portion of the cyst, which became enlarged and displaced the globe.

Another account of another of these curious and very rare cases is reported by Denhaene (*Archives Médicales Belges*, 11, 1912). An abstract of it appears in the *Ophthalmic Review*, Sept., 1913. A young soldier, a lancer aged 20 years, gave a history, in explanation of the peculiar behavior of his eye, of a blow at the lower outer margin of the left orbit, sustained by striking his head on a fixed stake, while he was bathing in a river. At the time there was very severe pain, some dimness of vision, and ecchymosis of lid and conjunctiva. These symptoms disappeared rapidly, and he was considered to have recovered, but a fortnight later, when blowing his nose, the patient felt the left eye suddenly "jump out" of the orbit, and subsequently return to place. At the date of consultation this phenomenon occurred at any forced expiration; this the patient took good care to avoid "for fear he should lose his eye." He stated that since the accident he had been somewhat liable to attacks of palpitation, breathlessness, and nervousness, these attacks being chiefly nocturnal. There does not appear to have been any definite proof of the genuine existence of these conditions, nor was tachycardia found to exist during the attacks. His eyes had always tended to be somewhat prominent; on examination there was no fault in the ocular movements whatever, the lids moved well, and showed nothing of v. Graefe's sign. There was no pulsation in the orbit, and no sign, when examined with the X-rays, of any fracture. The ophthalmoscope showed nothing abnormal; there was full vision in the unaided right eye, and in the left on correction of a small amount of myopic astigmatism.

When the patient voluntarily made an expiratory effort the left eye leapt forward as if worked by a spring; there was no deviation of the eye, it simply came directly forwards; on cessation of such effort the eye returned to its place at once. This protrusion was accompanied by somewhat sharp pain in the orbit; the pupil and ophthalmoscopic appearances remained unaltered, but vision became indistinct; mere mechanical compression of the jugular did not produce the symptom at all.

It seems all but certain that the peculiar behavior of the eye must

have been due to a form of vascular tumor or aneurism in the depths of the orbit which became heavily charged with blood when there was any temporary obstruction to the outflow of blood; this may be favored by a lax condition of the fibrous structures in the orbit.

The case seems comparable to those in which exophthalmos occurs [see **Exophthalmos, Intermittent**] whenever the patient bends forward, the eye receding again, sometimes even to an abnormal degree, when the erect position is resumed.

Exophthalmus pulsans. Pulsating exophthalmos.

Exorbitisme. (F.) Exophthalmos; also enucleation of the eye.

Exosis. (L.) Protrusion; dislocation.

Exosma. (L.) A protruded part.

Exosmometer. ENDOSMOMETER. An instrument for measuring the rapidity with which adjacent liquids pass through a membrane separating them.

Exostosis. OSTEOMA. A morbid bony outgrowth or enlargement; an osseous tumor. The conjunctiva and walls of the orbit are, though rarely, the sites of osteomata.

An *ivory* exostosis is a bony outgrowth of extreme hardness and of small size, rarely exceeding that of a small walnut. It springs usually from the exterior of one of the cranial bones, and is occasionally found attached to the orbital walls. Histologically, it is marked by the absence of Haversian canals. See **Tumors of the eye**; as well as **Osteoma.**

Exothermic. Referring to the chemical action of light.

Exothyropexy. This operation, generally done for relief or cure of Graves' disease, consists in freeing the thyroid gland from its environs and dislocating it upon the surface of the skin, where it is allowed to remain. As a result of atrophy and resorption, the gland gradually shrinks and becomes cicatrized. This operation has been practised chiefly in France, and there by but a few surgeons. Following exothyropexy, symptoms of acute thyroid intoxication are frequently noted from the escape into the tissues of the secretion of the gland. An improvement in the most favorable cases is extremely slow. See **Exophthalmic goitre.**

Exotropia. Divergent strabismus. See **Muscles, Ocular**; as well as **Divergence**; and **Divergent squint.**

Experiment, Hering's. This is a test of binocular or rather of stereoscopic vision. The person under examination looks with both eyes through a tube at a thread stretched vertically in front of it. Little balls are dropped alongside—sometimes in front, sometimes behind—the thread; if the patient has normal binocular vision he can tell at

once whether each ball has passed in front or behind the thread; otherwise he cannot, and often makes mistakes.

Expert testimony. See **Legal relations of ophthalmology**, in the first third of the section.

Expert witness, The ophthalmic. See **Legal relations of ophthalmology**, first third of the section.

Expiré. (F.) Exhaled.

Explement. The amount by which an angle is short of four right angles.

Explétif. (F.) Commissural.

Explorateur. (F.) Exploratory.

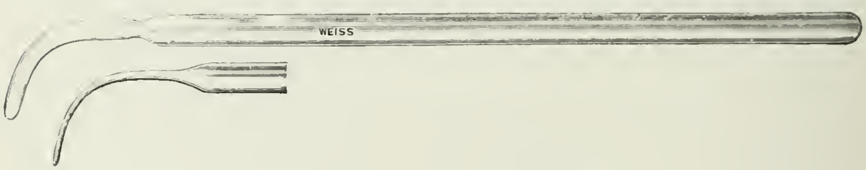
Exposure. In ophthalmic practice one sometimes speaks of the *exposure of ametropia—of hypermetropia*, for example. This means the revelation of hidden or latent hyperopia by means of cycloplegics, as a result of age, ciliary paralysis, etc.

Another sense in which this is used, ophthalmologically, is in connection with ocular hygiene, the *exposure of school buildings*, particularly in relation to their situation as to light and air.

In photography, the act of exposing a sensitive surface to light.

Expression. This term is generally applied to an operation in trachoma whereby the trachoma bodies are removed from their conjunctival situation by various instruments, rollers, forceps, etc. See **Trachoma.**

Expressor. An instrument for the expression or extrusion of the lens or of cataract. It has been almost exclusively employed in the expulsion



Pagenstecher's Lens Expressor.

of the cataractous lens in its complete capsule. One of the earliest expressors is that of Pagenstecher, although Henry Smith and others have devised similar instruments. See Vol. III, p. 1534, of this *Encyclopedia.*

Expuer. (F.) To expectorate saliva, mucus, or blood.

Expuition. (F.) Spitting out saliva.

Exsangue. (F.) Bloodless.

Exsarcoma. An obsolete term for sarcoma.

Exsudat. (F.) Exudate.

Exterioration. The mental faculty by which the image of an object seen is referred to the actual situation of the object.

Extériorité. (F.) The physical act by which sensations are referred to external objects.

Exterior ophthalmoplegia. OPHTHALMOPLEGIA EXTERNA. Paresis or paralysis of the external ocular muscles.

External bi-orbital diameter. The greatest transverse distance between the outer borders of the external orbital apophyses of the frontal bone.

External canthus. See **Canthus.**

External ophthalmoplegia. OPHTHALMOPLEGIA EXTERNA. EXTERIOR OPHTHALMOPLEGIA. Paresis or paralysis of the external ocular muscles.

Externa oculi. (L.) (Obs.) The sclera.

Externus. A common term for one of the extrinsic or external ocular muscles.

Extinction of color. The point in the diminution of the intensity of light which just causes the color to become invisible. As pointed out by Abney (*Color-vision,* page 105), orange is about the last color of the spectrum left, some of the others still appearing as grays. The next to retain its color is green, and the most rapid to lose them are the red and violet. Colors do not remain of the same hue up to the time they vanish. Pure spectrum red remains the same up to the last, but the scarlet becomes orange, and the orange yellower, and the green bluer. At nightfall in the summer the order of disappearance of color may often be seen; orange flowers may be plainly visible, yet a red geranium may appear black as night; the green grass will be gray when the color of the yellow flowers may yet be just visible.—(C. P. S.)

Extirpation. The complete removal or excision of a part.

Extra-atmospheric. Beyond or outside our atmosphere.

Extra-axial. Outside the axis.

Extracapsular. Situated outside a capsule, e. g., of the lens.

Extraction à lambeau. (F.) Flap-extraction.

Extraction of cataract. This subject has been fully discussed under **Cataract in general,** as well as under **Cataract, Senile,** and various other **Cataract** headings in Vols. II and III of this *Encyclopedia.*

Extraction of cataract in the unruptured capsules. Commonly known as the Smith-Indian operation. This procedure is of so much importance and has in late years attracted so much attention that it has been described and discussed in this *Encyclopedia* under a separate heading by its principal American advocate, the late D. W. Greene. See **Cataract, Intracapsular extraction of.**

Extracts of human eye tissues. Experiments with extractives from human eyes upon the ocular organs of the lower animals have been rarely undertaken. However, R. Wissmann (Graefe's *Archiv. für*

Ophthalm., LXXX, p. 399, 1913) has made a number of observations of animals treated with extracts from normal human eyes, and from injured eyes which were enucleated because of supposed danger to the sound eye. The eye as a whole was very toxic to the guinea pig, whether the animal had or had not been previously sensitized. When lens, vitreous, uveal tract and retina were, as far as possible, separately injected, the results were completely negative. But death of the animal followed two successive combined injections of extracts from each of the four parts of the eye, mixed in the proportion occurring in the normal eye. Further experiment pointed to the uveal tract and retina, and particularly the former, as carriers of the toxic substance. This substance is destroyed by heating to 100° C., and is soluble in alcohol and ether. It therefore probably belongs to the class of lipoids. No difference was found between the effect on the animal organism of extracts from normal and those from pathologic eyes.

Extract, Thyroid. See **Thyroid extract.**

Extradural. Outside of or external to the dura mater or its prolongations.

Extrait de fèves de Calabar. (F.) Extract of calabar bean.

Extrait thébaïque. (F.) Liquid extract of opium.

Extramission. Emission, as of radiation.

Extraocular. External to or outside the eye.

Extra-ocular iridotomy. Iridotomy in which the iris is allowed to prolapse or is drawn out through a wound in the cornea before the incision is made and is then replaced.

Extra-ocular muscles. The extrinsic orbital or recti muscles. See **Anatomy of the eye**; as well as **Muscles, Ocular.**

Extraorbital. External to or outside the orbit.

Extraordinary image. One of the images produced by the double refraction of calcite (q. v.), and which is observed to rotate around the *ordinary image* that remains stationary while the crystal is being turned.—(C. F. P.)

Extraordinary ray. In *optics,* the ray which does not follow the ordinary law of refraction in traversing a uniaxial crystal, through whose double refraction both the *extraordinary ray* and the *ordinary ray* are produced and polarized. The vibrations of the extraordinary ray are parallel to the axis; whereas, those of the ordinary ray are perpendicular to it. Also see **Calcite.**—(C. F. P.)

Extra-papillary. Outside the papilla or optic disc.

Extra-rectus. An obsolete term for the external rectus muscle of the eye.

Extrinsic. External; as extrinsic eye muscles.

Exudative choroiditis. This form of the disease is usually subacute or chronic and includes the disseminated, plastic and circumscribed varieties. See Vol. III, p. 2147 of this *Encyclopedia*.

Exudative diathesis. So far as ophthalmology is concerned Czerny (*Brit. Med. Jour.*, Apr. 23, 1910) is responsible for this term. He regards phlyctenular disease as one of its expressions. In his opinion, although the condition may yield positive tests with tuberculin, it is not tuberculous, being readily controlled by proper attention to diet. Excess of milk and eggs, and also of carbohydrates, is to be avoided.

Exudative erythema, Ocular complications of. The exudative erythemata are of interest to the ophthalmologist as well as to the dermatologist, because of the occasional manifestation of the disease on the conjunctiva. *Erythema multiforme* and *erythema nodosum* are the types of the disease which have been noticed to present such a complication. Because neither of these types can be said to be of common or frequent occurrence, and because cases presenting ocular symptoms occur but seldom, it has been thought well in this work to give a general outline of the dermatology of the affection and then to describe the ocular symptoms which have been observed.

The exudative erythemata are acute inflammations which occur in attacks of short duration but with a tendency to relapse at short or long intervals. The lesions, which sometimes become vesicular or hemorrhagic, are deep-red, symmetrical yet extremely diverse in shape, size and degree of elevation above the skin surface.

Erythema multiforme, as its name implies, presents a most varied aspect, occurring in numerous scattered or grouped lesions of various sizes and shapes. It is characterized by reddish or purplish macules, papules and tubercles, which occasionally become vesicular or bullous, or, more rarely, hemorrhagic.

While usually the body surface may be more or less extensively affected, the face is infrequently involved, and exceptionally it may be limited to it, thus involving the eyelids and occasionally the conjunctiva. The eruption, as a rule, makes its appearance suddenly, and may present itself as erythematous patches of more or less irregular outline, and of various forms, or it may consist of small, flattened papules or tubercles, or the eruption may be of a mixed character, but usually there is a predominance of one type of lesion. In the first few days the lesions are likely to increase in size, when they are soon followed by the appearance of new efflorescences. There may be fresh outbreaks daily, but by the end of ten days the process begins to decline. Other cases may present a single outbreak only, which remains stationary for a week or so, and then it gradually fades.

The efflorescences are of a bright-pink or red at first, becoming later, as a rule, violaceous or purplish, especially in the papular and tubercular forms of the disease.

The most common type, however, consists of papules which are small and flat, having sometimes a sunken-in central portion. The papules may be discrete or crowded together, in color dark or violaceous. They are frequently interspersed with larger and deeper-seated tubercles, and sometimes the papules are arranged in single and in concentric rings. The concentric formations occur successively, so that the outermost is the most recent, and therefore the patch is of different tints, hence "erythema iris." Others may consist of vesicular or bullous rings, of various hues, hence "herpes iris." Or, again, the rings may have sharply defined margins, indeed the patches may appear in many forms, making quite bizarre figures. The patches may coalesce and form large blebs simulating the eruption of pemphigus. In other cases vesicular lesions may be found on the lips and in the mouth.

Subjective symptoms may be entirely wanting, but in some cases only slight burning and itching are complained of, yet they are rarely troublesome. In the vesicular and bullous types, however, the patches are often painful.

The constitutional symptoms are usually insignificant, and, as a rule, in the average cases of the papular type limited to the face and hands, there are no perceptible systemic symptoms. There may be, however, a slight rise of temperature and swelling of the cervical glands. The eruption on the body may be preceded by inflammation or congestion, or an eruptive condition of the face and of the conjunctiva, and, when there is an extensive general eruption, the joints of the extremities may become swollen and painful. The disease usually, however, runs an acute and benign course.

The disease has been observed to occur more frequently in the changeable weather of the spring and autumn. One attack certainly predisposes to others, which for several years may recur at about the same time of the year. In such cases it may be accompanied by more or less pronounced rheumatic symptoms.

Erythema is most frequent during adolescence and early adult life, yet all ages are subject to it, and it is common in both sexes, but it has been seen more frequently in females. There seem to be no predisposing causes, but certain drugs, such as potassium iodide and the coal-tar products, have been followed by erythematous eruptions, and it has been noticed that antitoxins and serums have caused it. It is prone to attack newly arrived country people.

The pathologic cause of erythema multiforme is unknown. It is

quite probable that it is due to the absorption of imperfect products of digestion, and it therefore may be said to depend upon intestinal toxemia, as it has been found associated especially with the ingestion of stale fish, shell food and meats. It has occurred as one of the symptoms of pellagra, which may be considered to be a chronic intoxication induced by the ingestion of damaged maize. Nevertheless, it is believable that all cases must have an underlying neurotic basis, so that erythema may be regarded as a toxic dermatosis. Blood examinations have yielded nothing positive, neither have specific organisms been isolated in the serum contained in the vesicles. It has been found epidemic, in which case the symptoms have been grave.

Erythema multiforme is a mildly inflammatory disease, and it may be said to be allied to urticaria. The effusion is brought about probably by a casomotor disturbance depending upon an angioneurosis, which may be considered to be toxic in origin, impressing the nervous system and the peripheral circulation. Certain observers have considered it to be a form of purpura, because hemorrhages have been found, and as grave cases have exhibited such symptoms, their presence is therefore strongly suggestive of such a connection.

The epidermal changes are more marked in the bullous and vesicular types than in the papular. These changes consist of inflammation in the papillary layer as shown by dilation of the vessels with the proliferation and emigration of cells, together with edema and sometimes extravasation of serum and red blood cells. The epidermis is edematous, the edema reaching from the sub-epithelial vascular network. The covering of the vesicles and bullæ consists of the corneous layers and sometimes of the entire epidermis.

The diagnosis of erythema multiforme should rarely give rise to difficulty if the multiformity of the eruption, the size of the papules, the tendency to ring-formation, the cause of the disease and the absence of subjective symptoms are considered. It resembles urticaria, yet urticaria is intensely itchy and is evanescent, while erythema persists for several days, the papules of which are dark-colored, purplish or violet in hue and often present a slight depression of the central portion. When there are distinct rings it might be mistaken for ring-worm, but the surface of ring-worm is scaly, and when the vesicles and bullæ become confluent the large blebs may suggest pemphigus, yet in such cases the presence of other characteristics of erythema multiforme should clear up the diagnosis.

The prognosis is, as a rule in America, favorable, the eruption disappears in a week or two, although new crops may recur and the course

of the disease be prolonged. The graver cases are apparently more frequent in Europe.

It is doubtful whether the causes can be influenced by treatment. As it is probable that it depends upon the development of intestinal toxins, the best treatment consists of such antiseptic drugs as the saline laxatives, sodium salicylate, salol, or thymol in full doses. External treatment is simple. When there is intense itching, antipruritic remedies may be used. In cases characterized by recurrences, it is well to anticipate their return by the administration of saline and intestinal antiseptics previous to the time of the outbreak.

(The reader is referred to the admirable text-books on diseases of the skin by Crocker and by Stelwagon, from which much of the above account has been taken.)

Erythema multiforme involving the ocular structures is a rare affection in America, and in Western Europe. It is found in the East and in Turkey, more frequently in Italy, Roumania and Bulgaria, where it is said to be common. Cases have occurred from time to time as reported by observers in various parts of the world, yet works in ophthalmology have given small place to descriptions of the disease.

Beaudonnet, in his Paris Thesis, *"A Contribution to the Study of the Ocular Manifestations in Erythema Polymorphe,"* published in 1894, notes that a case was reported by Alibert so far back as 1822. Later writers have observed that conjunctivitis with lachrymation and photophobia occurred with such severity as to constitute a distinct complication of the major malady. Others have noted that a diffuse erythema may be found on the eyelids, with vesiculation, which later may be followed by scaling and pigmentation.

The occurrence of papules and vesicles on the eye are quite characteristic; the first appearances, however, are variable, although they usually appear in the course of the eruption on the skin. Rarely tiny rose-colored papules have been seen on the conjunctiva preceding the general efflorescence, but usually they appear at about the fourth or sixth day of the eruption.

The simplest symptoms consist in congestion of the conjunctiva with mucoid discharge, implication of the lid borders and agglutination of the lashes. The congestion of the conjunctiva is sometimes accompanied by edema of the lids. Both eyes are commonly affected, but it may be confined to only one eye. The papules are commonly found at the inner angle, where they give one the impression of pterygium. In other cases they appear to be more like nodules of episcleritis, yet here the papules consist of more or less circumscribed, elevated buttons over which the conjunctiva can glide on to the globe. The most

marked areas are violaceous and have the same color as the papules and vesicles on the skin. Others may be paler and stand out distinctly on the injected conjunctiva. These opalescent papules are sometimes surrounded by whitish vesicles, which may break down into ulcers. In from five days to two weeks all the phenomena amend, the photophobia and lachrymation cease, the nodules diminish, and the papules fade at the same time as those of the general eruption, then they vanish and leave no traces behind. Cases have lasted longer, merging into a more or less chronic state.

More severe cases have arisen in which a false membrane has formed on the tarsal conjunctiva, accompanied by similar formations on the pharynx. It is likely that such severe lesions are really secondary to contamination by other infections because chains of cocci have been found in them, while usually erythema papules are sterile.

The membranes may be thick, and, stretching from the lid margin to the globe, covering the plica, give the appearance of symblepharon. Such membranes are not true, but false, for they can be detached. These cases are likely to be quite serious and the cornea may become implicated. Instances have been recorded where the cornea has been infiltrated beneath the denuded epithelium, yet without invasion by septic bacteria.

These conjunctival complications represent a real manifestation of the specific disease exhibiting modifications according to the differences between the structure of the skin and of the mucous membranes, subject to the changes connected with differences of environment and function. Moreover, no true affections of the conjunctiva correspond to erythema or to herpes iris. The catarrhal form of conjunctival erythema represents the erythematous form on the skin, and the croupous is the vesicular or bullous, modified by the character of the mucous surfaces. It is important not to confound this quite benign eruption with pemphigus, which so frequently terminates in xerosis and symblepharon.

Erythema nodosum is an acute inflammation of the skin characterized by the formation of various-sized, roundish, more or less elevated erythematous nodes or swellings attended with a variable degree of systemic disturbance.

It is usually ushered in with febrile disturbance, gastric uneasiness, malaise, and, not infrequently, with rheumatic swellings and pains about the joints. These constitutional symptoms may be mild and scarcely noticeable, or they may be quite severe. The cutaneous eruption makes its appearance either with, before or after the constitutional symptoms. The lesions commonly affect the arms and legs, but

they may occasionally be found on the face, and rarely in the mucous surfaces of the mouth and throat and in the conjunctiva. Rarely are they found in great numbers, but come out two or three at a time. They begin as deep-seated nodules, rapidly becoming larger and elevated. On the general surface they may become as large as a hen's egg, and are rounded or oval, tender and painful, and have a glistening and tense look, of a bright, erysipelatous color, and as they are not circumscribed, the color gradually merges into sound skin. Later the eruption becomes of a "black and blue" color, gradually changing and fading in the manner of a bruise. At first they are quite free, but later undergo softening and fluctuate; they may become hemorrhagic, but they never suppurate. The nodes do not all come out at once; at first there may be but three or four, but after a few days others may appear. In the course of a few weeks, or in some cases months, the process fades and entirely disappears.

There may be rather severe subjective symptoms accompanied by throbbing, tenderness and pain. The constitutional symptoms subside after a few days, though some cases may continue febrile for several weeks, with the persistence of severe visceral and cerebral complications. The disease is usually found in those under 30, females being more often attacked than men, and commonly in cold and damp weather. The subjects are usually the weak and anemic, though it may attack those in good health. Rheumatism frequently accompanies it and it may be associated with malaria, digestive disturbance and intoxications.

It is not a common disease. It sometimes occurs in two or more members of a family. Its nature is not clear; it is not improbable that it is due to septic infection. The grave cases may be due to septic infection. Its association with tuberculosis is chiefly a coincidence, or at most tuberculosis acts as a predisposing factor; and the same may be said of its relation to syphilis. It has been said to bear a strong relation to erythema multiforme, and to be a manifestation of that disease. There is some difference of opinion as to how the lesions are produced; it is still uncertain whether it is an angioneurosis, or whether it arises from inflammation of the lymphatics or from embolism. There is a distinct inflammation, however, for the blood vessels are dilated, the corium and papillary layers are crowded with cells, accompanied by extravasations of blood and transudation of coloring matter. The lymphatic vessels are packed with cell collections, and in the blood vessels, especially the veins, there is great massing of the leucocytes. The epidermis rarely shares in the process, but the cutaneous and subcutaneous tissues are infiltrated with serum.

Erythema nodosum must not be confounded with bruises, abscesses, etc. The color of the eruption with the later changes; the violent character of the process; the number of the lesions with the course of the eruption ought to prevent error in diagnosis. Bruises and abscesses are rarely seen more than two or three in number; the erosions of erythema nodosum never break down, while the disease is frequently accompanied by rheumatic pains in the joints.

The prognosis is favorable, although the disease usually requires a few weeks, perhaps two or three months, to run its course. In this country the disease is mild and ought to give rise to but little anxiety, as it always ends in recovery.

The disease should be treated symptomatically. Rest should be strictly maintained. The diet should be plain and unstimulating. The alkalis, salines, laxative and intestinal antiseptics, quinine in full doses, constitute the essence of the treatment. Rheumatic joints need wadding.

Just as ocular complications have been found in erythema multiforme, so have such been seen during the course of erythema nodosum, and the ocular manifestations arise and fade as the eruption appears and disappears in the general malady. The nodosities are larger and denser than the nodes found in erythema multiforme, and as the systemic condition is more profoundly depressed, the frequence of deep-seated ocular disease has likewise been greater. Thus the eyeball may be tender on pressure; there may be bilateral iritis, and general uveitis with atrophy of the optic nerve have been recorded.

In erythema, or *herpes iris*, or *hydroa*, the general symptoms are comparable to those already described, but the chief distinguishing feature of it is the formation of a ring of vesicles about a central bulla. There may be several concentric rings.

The disease usually recurs annually, and at about the same time each year, but with lessening severity as the years go on.

Enormous bullæ have been seen on the conjunctiva, unaccompanied by serious symptoms however, as they fade without contracting the conjunctiva and without affecting the cornea.

In the progress of the early symptoms of these types of erythema, one naturally thinks of pemphigus, but because their course is usually brief and the immediate symptoms moderate, their status is discerned, for the effects are benign, whereas pemphigus invariably leads to absorption of the conjunctiva with contraction of the tissues and the consequent formation of symblepharon.

In all these conditions the local treatment should be expectant. The lids may be protected by boric acid ointment or other bland salves,

and in simple cases astringent lotions may be prescribed. When the bullæ on the conjunctiva are of great size, the snipping of them to drain off the contents might be practised, but in such cases extreme care should be used to prevent infection of the raw surface thereby exposed. Deeper-seated troubles must be managed on general principles.

All cases require a searching for any cause of defective health. The food should be inspected as to its freshness and purity, as well as to its preparation and digestibility. The system must be supported, the intestinal tract cleansed and kept as antiseptic as possible. Recurrences must be anticipated, and the patient protected by the means already outlined.—(B. C.) See, also, **Skin diseases, Ocular relations of.**

Exudative retinitis. Retinitis hemorrhagica externa. Massive retinal exudation. Of this rare and curious disease de Schweinitz (*Diseases of the Eye,* p. 610, 1913) says that the most conspicuous feature is a large, prominent yellowish-white circumscribed lesion, or smaller areas of yellow or white exudations lying beneath the retinal vessels. Of insidious onset and slow progress, the disease most often attacks young persons (average age about nineteen), and is more common among males than females. The patients are usually in good health (anemia may be present), and their clinical and family histories do not yield information as to the etiologic factor. In late stages of the disease detachment of the retina, cataract, iritis, and glaucoma may develop. The affection depends, as Coats has shown, upon hemorrhages in the inter-retinal layers. A slow organization takes place with formation of cicatricial tissue masses. At first the choroid remains free from pathologic alterations. This form of retinitis is probably the result of local vascular disease; ophthalmoscopically, it has most often been mistaken for tuberculous choroiditis.

The *Ophthalmic Year-Book* for 1913 furnishes the following references. A case which he believes to be of this character is reported by von Hippel (Graefe's *Arch. f. Ophth.,* Vol. 86, p. 443). The patient was a man of 49, with negative Wassermann and tuberculin reactions. Enucleation was done about fifteen months after the onset. The retina was thickened and detached, with nodules projecting from the outer surface and a layer of organizing tissue between it and the choroid. A similar layer was present on the inner surface of the retina, which had undergone much degeneration, and was invaded and destroyed by cicatricial bands. The retinal vessels did not show gross disease. The anterior choroid was infiltrated and its inner layers disorganized. Von Hippel supposes the disease began anteriorly and spread back-

ward. Coats (*Ophth. Rev.*, Vol. 33, p. 51) thinks the round cell infiltration of the choroid in this case makes it questionable as a case of exudative retinitis. But such borderline cases should be welcomed for the assistance they give in exact classification.

Another borderline case is reported by Hajano (Graefe's *Arch. f. Ophth.*, Vol. 84, p. 30), occurring in a boy 2 years old. The eye was enucleated on a diagnosis of glioma. But section proved this erroneous. The retina was detached, thickened, folded and degenerated, with cystoid spaces. The vessels were thickened, knotty, and some completely obliterated by proliferation of the inner coat. The choroid, ciliary body and iris were also thickened, but without inflammatory changes. Hajano also reports three cases in which white exudates behind the retinal vessels were found in different parts of the retina in young otherwise healthy persons; and suggests that these may represent an early stage of the same trouble. A case is reported by zur Nedden (*Klin. Monatsbl. f. Augenh.*, March, 1913, p. 359), as possible glioma, in a 17-year-old patient. The retina was thickened with shiny white spots, the vessels tortuous and dilated. The Wassermann and tuberculin reactions were negative.

Exulcéreux. (F.) Phagedenic; derived from an ulcer.

Eye-ache. Dolor oculi. Ophthalmodynia. These are indefinite terms applied to those pains that, due to many different causes, affect the eyeball and the region of the orbit. Although they generally result from eye-strain, yet they often form one of the symptoms of certain inflammatory diseases of the eye, neuritis, odontalgia, nasal sinus disease, etc., or they occur as part of a hemicrania. The treatment of this symptom is, of course, entirely dependent upon its cause.

Eye-and-ear observation. An astronomical observation by the method in which the time is fixed by the ear, by noting the beat of a clock, while the transit of the star is observed in the telescope.

Eye, Artificial. See Vol. I, page 621 of this *Encyclopedia*.

Eye, Axis of the. See Vol. I, page 722 of this *Encyclopedia*.

Eyeball. Ocular globe. Sometimes, though incorrectly, termed the *bulbus*. See in particular **Anatomy of the eye**, as well as **Development of the eye.** Although a few lesions or states of the eyeball as a whole will be considered under the next following headings, yet the reader is referred to headings that indicate the condition itself, such as **Epibulbar tumors**; **Enucleation of the eye**; **Ocular muscles**, etc.

Eyeball, Atrophy of the. Phthisis bulbi. Plastic inflammation of the uveal tract (iridochoroiditis) often ends in a condition in which the

eyeball becomes soft and lessened in all its diameters. The globe is irregular in shape from wrinkling of the sclera. The retina becomes detached. When the exudation lies chiefly behind the lens, the anterior chamber will become shallowed. If the force of the contracting exudate is exerted more in a backward direction, the chamber will be deepened. The condition is known as phthisis bulbi. See, also, Vol. I, page 667 of this *Encyclopedia*.

Eyeball-heart reflex. Loeper and Mougeot (*Journ. Am. Med. Assocn.*, Feb. 14, 1914) confirm the instructive import of Aschner's reflex, the slowing of the heart-beat when pressure is applied to the eyeballs. In two or three seconds at most, the heart slows up by about 8 beats to the minute, but the former rate returns as soon as the pressure is released. In tabes this reflex seems to be abolished. In some cases the absence of the oculo-cardiac reflex, as they call it, was the first sign to attract attention to the tabes. The apparently paradoxic tachycardia with abnormally high blood-pressure does not affect this reflex, but this tachycardia warns of impending breakdown of the left heart and calls for digitalis unless it yields to other measures. They explain the mechanism of this tachycardia, saying that the eyeball-heart reflex first threw light on it. They published several communications on the reflex in the *Progrés mèdical,* 1913, xli, 211, 663 and 675. With a gastric neurosis this reflex is an indication whether the pneumogastric or the vagus is predominantly involved, and this may prove a guide to treatment. In one of the cases reported the patient had an ulcer on the lesser curvature, and the pulse slowed up by 14 beats on pressure of the eyeballs. Three months after resection of the stomach the pressure caused the pulse to drop from 88 to 62, a loss of 26 beats. The pressure on the eyeballs never seemed to do any harm. It exaggerates bradycardia when it is of nervous origin, and may exaggerate arhythmia. With rudimentary exophthalmic goitre and in very emotional subjects, with a tendency to "hot flashes" and profuse sweating, pressure on the eyeballs is liable to accelerate the pulse.

Eyeball, Movements of. See **Physiological optics**; as well as **Muscles, Ocular.**

Eyeball, Position of the. The globe is placed not in the axis of the orbit, but below and external to it. The prominence of the eyeball is largely dependent upon the amount of adipose tissue in the orbit: the greater the amount of adipose, the greater is the prominence. In emaciated subjects the eyeballs are sunken from diminution of the fat of the orbit. During sleep or unconsciousness the eyes turn slightly upwards and inwards.

Eyeball, Tension of the. See **Glaucoma**; also **Tonometer.**

Eye-box. A name given to a receptacle for single artificial eyes. See the illustration.

Artificial Eye Box.

Eye, Brassy. Chalkitis. Chalcitis. Vulgar name for a severe inflammation of the eyes marked at first by excessive lachrymation and sensitiveness to light, resulting in blurred vision and continued flow of mucus. It is due to rubbing the eyes after the hands have been used on brass, as in the case of trolley-car conductors and employes of brass or copper works.

Eye-breek. An old name for the eyelid.

Eye-breen. An obsolete term for eyebrow.

Eyebright. Once supposed to be of marvelous efficacy in clarifying the vision. See **Euphrasia.**—(T. H. S.)

Eyebrow. The supercilium. The eyebrows, generally nearly straight, except in the outer part which slants downward, but sometimes decidedly arched throughout, are of very varying development. They are composed of coarse, stiff hairs pointing outward. The inner half corresponds pretty closely to the upper border of the orbit, but the outer half, on account of the downward slope of the orbit, is above it, resting against the forehead. Sometimes the outer half is wanting. Sometimes, especially in dark-haired races, the eyebrows meet at the root of the nose. The inner half is the strongest and thickest. At the outer end the hairs are fewer and smaller. The lower hairs slant upward, and the upper downward as well as outward. Thus they meet to make a raised crest in the middle. The shape depends largely on the direction of the outer end. The eyebrows are but little developed in infancy. They rarely are strong in childhood. At about puberty they become more marked. The hairs grow longer and coarser throughout life, especially in men. In women this feature is more delicate. Individual differences are endless.—(Norris and Oliver, *System of Diseases of The Eye,* Vol. I, p. 79.)

Eyebrow, Piebald. Patches of white hair in a dark eyebrow.

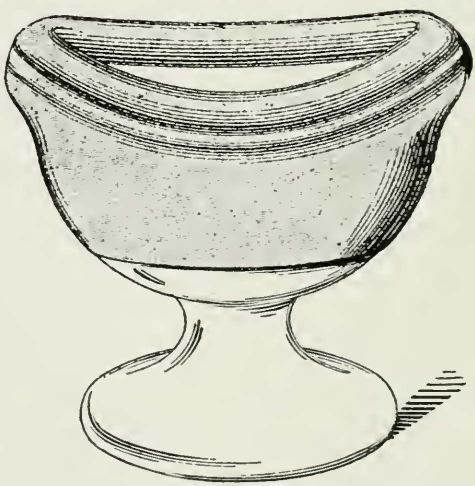
Eyebrows, Supernumerary. These are not so very uncommon. The usual type is that described by Majocchi (*Klin. Monatsbl. f. Augenh.*, Nov.-Dec., p. 655, 1908), who observed double rows of eyebrows 8 to 10 mm. apart with smooth skin between. A low grade of microphthalmos with hydro- and acrocephalus was also present. Dodd has observed islets of hair in each temporal region; the patches in no way resembled moles.

Eye-cells. Cup-shaped cells of porcelain, enameled black, to place over the eye after operations.

Eye, Compound. The organ of vision formed by several crystal spheres, as in Spiders and Crayfish. See **Comparative ophthalmology.**

Eye, Corrosion of the. A term used to express a burn by strong acids or alkalies.

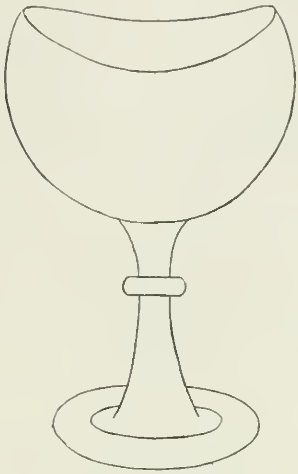
Eye-cup. There are many receptacles for retaining collyria in contact with the globe and conjunctival sac for detergent purposes. Of these



Eye-cup of Coulomb with Adaptable Rubber Rim.

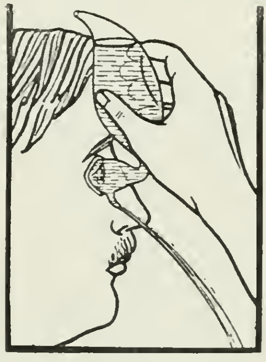
the ordinary eye-cup is a useful means of washing out the conjunctival sac. In using it the cup should be half filled with the irrigating fluid, then fitted snugly about the margin of the orbit. The head should then be tilted back, or the patient lie down, the previously closed eye opened and the liquid allowed to flow into the sac. Now open and close the eye slowly half a dozen times so that the irrigating fluid may come directly in contact with all the parts in and about the sac. Shut the eye, remove the cup and keep the lids closed for a few minutes.

An ingenious device is the eye-cup of Meyer-Steinig. It is one of many appliances intended to provide for continuous irrigation of the external parts.



Eye Cup.

H. C. Fenton believes that instead of using the ordinary cleansing collyria, that are likely to decompose, it is preferable in all cases to direct the patient to dissolve one-fourth teaspoonful of pure crystalline boric acid in one-fourth glass of hot water and use with an eye-cup.

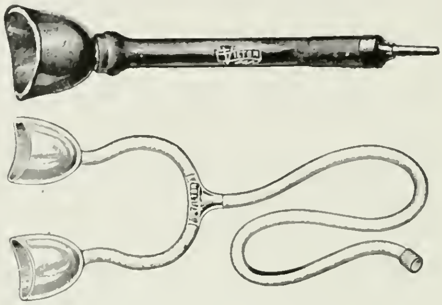


The Meyer-Steinig Eye-cup.

This avoids the manifold dangers of dirty droppers and contaminated solutions.

Eye-cup for pneumo-massage. These cups, mostly used in *Bier's artificial congestion treatment* of the eye (see Vol. II, p. 950 of this *Encyclopedia*), are made of clear glass, through which the operator can clearly

perceive the action that is taking place during treatment. They are moulded to conform to the shape of the eye-ball as closely as possible. They can be used in connection with any ear pump, or with any apparatus capable of compression, suction or vibration of the air. See the illustration.



Glass Eye Cups for Pneumo-massage.

Eye current. An appreciable electric current which may be observed in a freshly removed eye, if it is placed in a suitable galvanometer-circuit. Its direction is from the cornea to the cut section of the optic nerve. It is temporarily increased by the action of light.

Eyed. Having an eye, or visual power.

Eye, Development of the. See **Development of the human eye.**

Eye, Dioptrics of the. See **Dioptrics.**

Eye douche. See p. 4071, Vol. VI of this *Encyclopedia.*

Eye-dropper. In addition to the items furnished under the caption **Dropper,** cuts are herewith given of the well-known Strohschein

Strohschein's Eye-Dropper.

pipette and of the convolute eye-dropper that fully indicate the form and mode of using these useful little devices.

The convolute dropper receives its name from a spiral glass tube arrangement in the neck of the device, as may be seen by referring to the cut. This "pigtail" prevents any of the solution rising into the top of the dropper and coming into contact with the rubber. This is prevented even if the dropper is allowed to lie on its side. The bottle contains approximately one ounce and has a comparatively broad base. The rubber cap is made of the best quality bandage rubber, is greatly superior to the ordinary rubber top, besides being easily removable.

Convolute Eye-Dropper.

Eye, Embryology of the. See **Development of the human eye.**

Eye, Emmetropic. See **Emmetropia.**

Eye, Equator of the. See **Equator.**

Eye, The evil. See **Evil eye.**

Eye, Examination of the. See **Examination of the eye.**

Eye-fatigue. A synonym of asthenopia. This symptom may be due to ametropia, heterophoria, abnormal work, ill-health, general mental or physical fatigue, poor conditions of illumination or a combination of two or more of these causes. The Ferree test, devised by Prof. C. E. Ferree of Bryn Mawr College, is as follows: The observer under test is required to gaze steadily for a short period of time (usually about three minutes) at a card upon which are printed certain letters, or characters; these letters being of such a size that they are just barely distinguishable at the distance selected for the test. During the period of time that the observer gazes at the letters he is required to record on a chronograph or stop watch by the pressing of a button the intervals when the test object appears blurred. The percentage of the time which the observer sees the letters blurred is taken as an indication or measure of the amount of fatigue of the eye at the time the

test is made. Before beginning such a test it is of course important to determine the proper distance at which to place the test card from the eye of the particular observer under test, because if too great a distance is taken the test letters may appear blurred during the entire test interval, in cases where there has been considerable eye fatigue; and on the other hand if too short a distance is taken the observer may see the test letters clear for the entire time during tests when the eyes are but little fatigued.

Eye-Fix. The trade name of a rather popular quack remedy, advertised as a panacea for ophthalmic ills.

Eyeglasses and spectacles, History of. The subject of glasses as aids to vision is a matter of conjecture and tradition with an admixture of superstition previous to the middle ages. A Chinese emperor is said to have used lenses to observe the stars in 2283 B. C. The tortoise was a sacred animal to the Chinese; therefore tortoise-shell rimmed glasses were considered conducive to good fortune and long life. Lenses were made of rock crystal, quartz, topaz and amethyst. These stones, found among the sacred mountains, further insured good luck. Moreover, frames did not necessarily imply lenses; for even in modern times a frame devoid of lenses is a badge of superior social status and learning among the Chinese. An interesting etiquette has grown out of this symbolism; an inferior must remove his glasses in the presence of a superior. This custom survived in Germany until a very recent date.

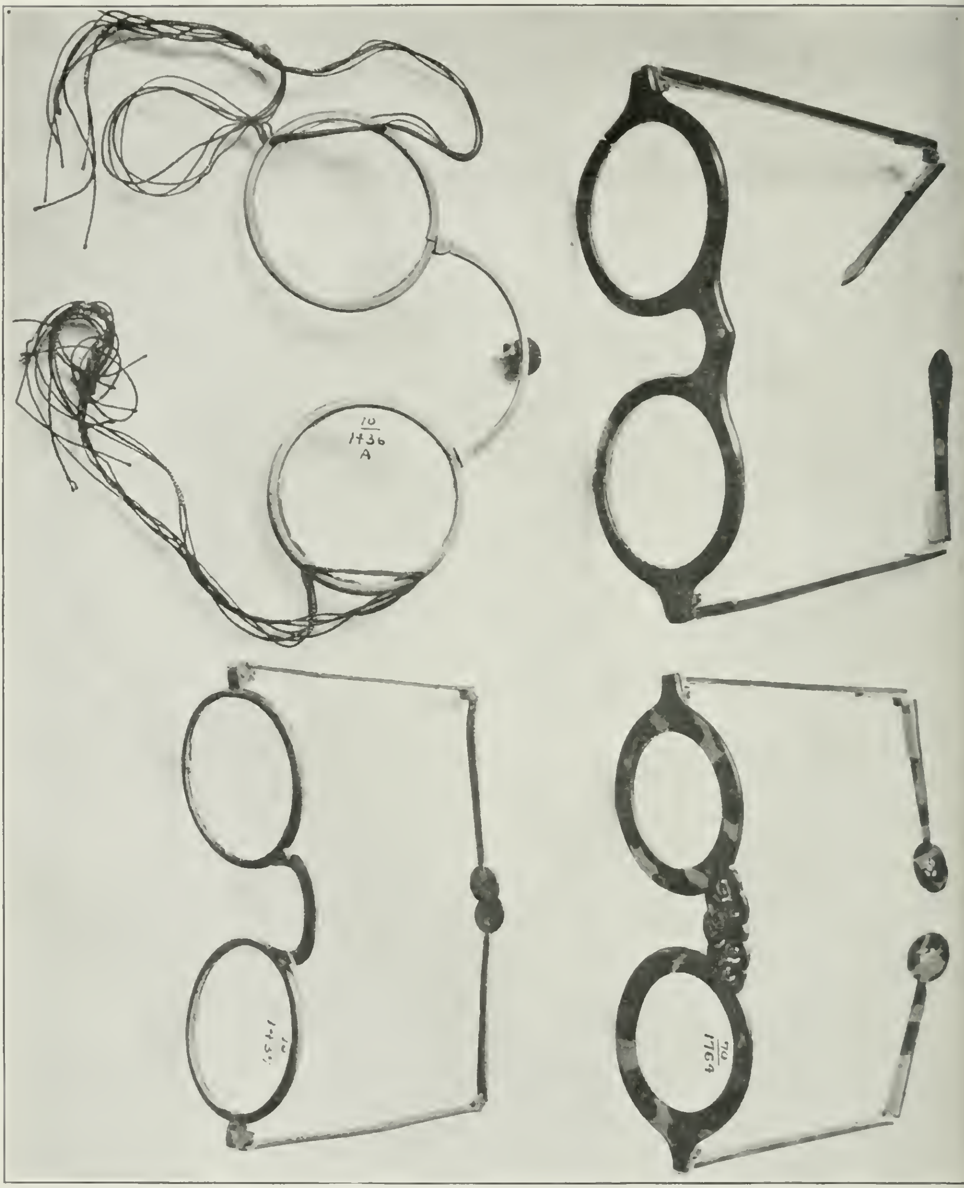
There is no evidence that the Hebrews, Greeks, or Romans had any knowledge of glasses. The well-known story of Nero viewing the gladiatorial games is not credited by scholars. The probable explanation is that Nero used a large concave mirror from which the scenes were reflected. Pliny, in the first century A. D., says that the Phœnicians learned the art of glass making from the Chinese, and that Phœnician nitre merchants discovered that nitre mixed with sand was melted by the sun's heat into a coarse glass. The remains of convex glass found in the excavations of Nineveh and Pompeii do not prove a knowledge of the use of lenses worn before the eyes, for the focus of these glasses is too short. Nevertheless we are tempted to assume such knowledge as essential to the minute and exquisite work of the ancients in gold and precious stones. The hollow globe filled with water may have served this purpose. It is certain that the ancients used such a globe which may have been part of the armamentarium of physicians. The magnifying and heat-producing properties were, however, attributed to the water, and it was a source of wonder that cold water could produce heat.

The Saracen mathematician and astronomer, Alhazen (died 1038), knew something of optics. The Latin translation of his work, still extant, treats of refraction in reference to astronomical instruments. There is reason to believe that his work was known to Roger Bacon. The high state of scientific knowledge among the Arabians would make it seem likely that they were familiar with glasses; yet there is no evidence to substantiate this surmise.

Hirschberg (Graefe-Saemisch *Handbuch der Augenheil.*, II, Band 13, 265) thinks that the Chinese used lenses only as mirrors and for kindling fire and that their knowledge of glasses came from Europe at a comparatively late time. Another view is that this knowledge spread from eastern Asia to Europe during the middle ages. In the thirteenth century A. D., following the inroad of the Tartars into Europe, the Pope sent missionaries to China to learn the wisdom of the East. One of these missionaries later visited Roger Bacon in Paris. Here is suggested another link between Bacon, around whose name the discussion as to the origin of glasses has centered, and his predecessors.

There is room for much speculation in regard to the communication between Europe and the Orient in medieval times and the possible origin and spread of glasses from one to the other. One may cite the instance of the introduction of the mariner's compass and of gunpowder in Europe and the claim that they are European inventions, whereas they were actually known at an earlier date in the East. To the Moors in Spain, to the crusades and the oriental trade of the Venetians, may be traced much of European culture.

Whatever be the theories, all unproven, of the origin of glasses, we have historical data for the statement that they were known in China and in Europe in the thirteenth century. During the Mongolian Dynasty (1260-1367) old people used lenses to distinguish small print. The older Chinese word for lens means "muddy cloud;" in later times a word corresponding to the German "Augenspiegel" (eye mirror) was applied to transparent glass. These medieval glasses are said to have come from Turkestan. Prisoners from Turkestan made glasses which were regarded by their Chinese captors as treasures; so valuable were they that they could be traded for horses. The statement that Chinese glasses were imported from Malacca refers to a later time, for Malacca is first mentioned in Chinese literature in the fifteenth century. In the thirteenth century, however, China was in close touch with other Asiatic nations following the migration of the Mongolian tribes. Laufer, to whose studies we owe our knowledge of this subject (*Mitteil. zur Geschich. der Medizin und der Naturwis.*, Bd. VI, Nr. 4, 379), thinks



Chinese Glasses. (From the collection of the American Museum of Natural History, New York.)

that the culture relations of the Asiatic peoples of this period make it reasonable to attribute the source of glasses to India, whence they reached China through Turkestan. Allowing for the time necessary for this transit, he dates glasses in India at the end of the twelfth or the beginning of the thirteenth century. The Chinese learned of the making of ordinary glass from the Romans in the early Christian era, and they came in contact with Arabian traders in the coast towns of southern China in the eighth century. Rock crystal is widespread in China and to it superstition attributed miraculous powers. It is to be noted that early Chinese glasses were of essentially different design from early European glasses, being large lenses, oval rather than round, with rims of tortoise shell and bows of brass or copper resting against the temples. European glasses of the thirteenth century, on the contrary, were nose glasses with circular lenses. The Chinese variety conforms to the type found in Asia and suggests a separate origin from the European. Beginning with the early eighteenth century European glasses were imported into China and have since been the prevailing type.

At the time when glasses were coming into use in China (the end of the thirteenth century), the same invention began to attract notice in Europe. The name of Roger Bacon, the English monk-philosopher, looms large in many matters of scientific concern at this period. So great was his learning and so extensive the range of subjects treated in his writings that he has gained credit for numerous inventions. It is certain that he knew of glasses and understood something of optics, but it is not certain that his knowledge was original. A definite claim of priority to Bacon comes from Italy, where Armati was said to have invented glasses in 1285. On a tombstone in a Florentine church was found the inscription: "Here lies Salvino d'Armati of Florence, the inventor of spectacles. God forgive him his sins. Died in the year of our Lord 1317" (see p. 594 of this *Encyclopedia*). Alessandro della Spina, a Dominican friar of Pisa, is said to have learned the art from Armati and to have devised glasses by a method he refused to divulge. Giordano da Rivalto, a distinguished clergyman of the time, said in 1305 that he had seen the man who invented glasses, but he did not give the inventor's name.

Opposed to the Italian claims is the consideration that Bacon was the most learned man of his time, as attested by his monumental work, the *Opus Majus* (1268), which antedates the supposed invention of Armati by seventeen years. This work treats of the science of optics. Bacon made drawings of biconvex lenses; he was acquainted

with the shape of the crystalline lens; he advised the use of lenses by the old and those who have weak eyes for the purpose of magnifying objects viewed. Bacon's knowledge may well have been transferred to Italy by one of the members of his ecclesiastical order, who made a prolonged stay in Florence, where he was detained on a journey to intercede with the Pope in behalf of his order. With meager communication among the several countries of Europe, a new invention might readily be credited to each community in which it appeared.

With characteristic conservatism clergy and medical profession condemned the new remedial agency. Bernard Gordon, professor in Montpellier, was the first physician to mention glasses, which he declared to be unnecessary if his famous eye remedies were used. Guy de Chauliac, physician to several popes, recommended glasses if his own eye lotion did not first effect a cure. Though individual monks used and praised glasses, the church authorities at first regarded these man-made devices as impertinent efforts to defeat the divine purpose of inflicting disabilities upon the aged. Bacon had already been imprisoned for dealing in "black magic" and he had abundant reason for not wishing to increase his notoriety; hence we may understand his failure to clarify his own connection with the subject of glasses.

To summarize: the inventor of glasses is unknown; the nations of antiquity probably knew nothing of these instruments; the ancient classics are devoid of reference to glasses. Alhazen seems to have made no practical use of his knowledge of optics. Near the end of the thirteenth century convex spherical lenses came into use in China and in Europe. It is probable that neither obtained their knowledge directly from the other. European evidence favors the view that Roger Bacon made glasses independently of Chinese influence or discovered the invention of some learned predecessor.

Probably the earliest illustrated scientific work on the use of spectacles was written by Daza de Valdes (Benito), a notary of the Inquisition at Seville. The sub-title reads as follows: "Uso de los antoios para todo genero de vista; En que se enseña a conocer los grados que a cada uno le faltan de su vista, y los que tienen qualesquier antojos." Impresso en Seuilla, por Diego Perez. Año de 1623.

The frontispiece presents a wood-cut portrait of the author with diagrams. The work is a quarto of 100 pages, printed on thin water-marked paper. It is dedicated to Our Lady of Fuensanta, whose appearance at the city of Cordova is also celebrated (as an introduction) in a poem written by a friend of the author. Tables for sight testing are given. This book is of excessive rarity; and there is no copy in the British museum.

The earliest known lenses seem to have been intended exclusively for the relief of presbyopia, the strongest lenses being + 3.00 spheres. They were plano-convex or weakly concave on one side. It is probable that they were first used as the modern hand glass held close to the object viewed, and only gradually were methods devised to secure the glasses before the eyes. These primitive devices were essentially eyeglasses and not spectacles. They consisted of one, or two, lenses surrounded by heavy rims. Greeff (*Bericht der 39th. Heidelberg.*

Medieval Painting Showing Eyeglasses.

Ophthalmolog. Gesell., 1913) thinks that the usual opinion that the monocle was the original device is incorrect, but that the eyeglass with two lenses preceded, and the monocle followed as an affectation. The rims, of various materials, metal and leather, were joined by a solid bar or bow. These might rest against the nose, but were insecure and must be held by the wearer's hand. For convenience handles were attached, so that the hand rested at the chin or on the forehead. One model shows a branched handle attached to both rims and

joined below the chin. Another was attached to the wearer's cap; this is still seen in Persia. Cords were tied about the ears or suspended over the ears.

The oldest pair of glasses in preservation is in the Nuremberg museum, to which they were donated by the antiquarian, Jacques Rosenthal, of Munich, who found them in an old volume of the latter part of the fifteenth century, Greeff *(Zeitsch. für Ophthal. Optik,* July, 1913). These are of the primitive type of round rimmed eyeglasses with a solid bow joining the rims. They are made of leather, partly of natural color and partly black. The lenses are lacking.

Virgin and Child. (Galleria Corsini, Rome.)

The frames are larger and thicker, and therefore thought to be older, than the interesting glasses of Wilbrand Perkheimer (1470-1530), also in the Nuremberg museum. Greeff (*Arch. für Augen.* 72, Heft 1, 1912.) When Perkheimer's house was torn down in 1867 and removed to Wartburg, where it remains as a memorial to the worthy burgomaster who was a friend of Martin Luther and Albrecht Dürer, an ancient pair of glasses was found in a cranny of the wall, where they no doubt fell from the wainscoting on which the old man placed them when he laid aside his reading. They are of leather polished black on the front surface. These glasses, like the older pair described, are the common type seen in the pictures and tapestries of the middle ages.

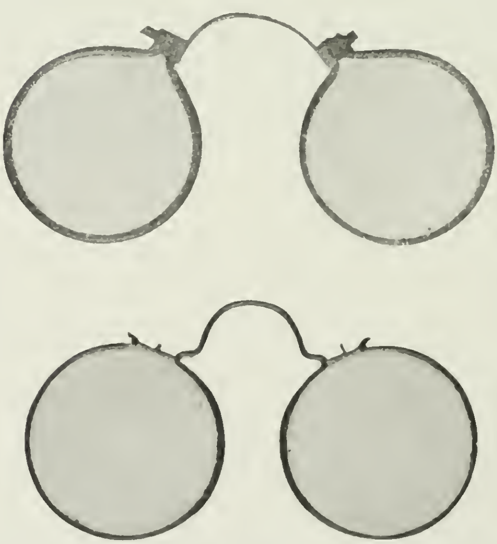
Most instructive and interesting are the anachronisms in the art

of this time. Men of learning and dignity are portrayed with glasses in their hands or before their eyes. As Shakespeare ignored the inconsistency of placing the inventions of his own day in the scenes of historical plays representing more primitive times, so the medieval artists did honor to their historical characters by furnishing them with glasses. A favorite honor to the donor of a picture painted for a church was to include the donor's portrait in one corner of the canvas, indicating his high position in the intellectual world by painting a pair of glasses on his person. But the donor was not the only favored one. Even so far back as the Garden of Eden do we find

Saint Jerome. (By Poilly.)

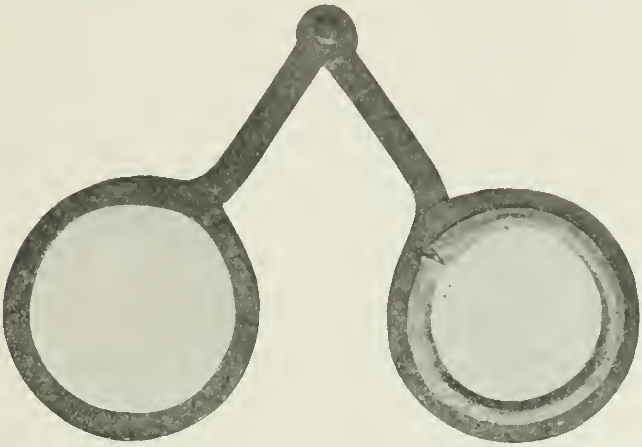
these aids to vision, as shown in the Spanish tapestry called the Creation of Eve, in which an aged priest sits reading with eye-glasses on his nose. In the collection of the late Benjamin Altman, of New York City, was a painting entitled Bathsheba After the Bath, in which an old serving woman wears glasses. This is an unusual conception of the artist, for only the characters of dignity and importance are ordinarily pictured with glasses. The picture called the Circumcision of Christ contains a pair of glasses worn by the High Priest. The Death of the Virgin presents another such anachronism; an apostle is wearing nose glasses. A beautiful painting, whose style suggests Leonardo da Vinci shows the infant Jesus in his mother's

Primitive Types of Eyeglass. (After Greeff.)

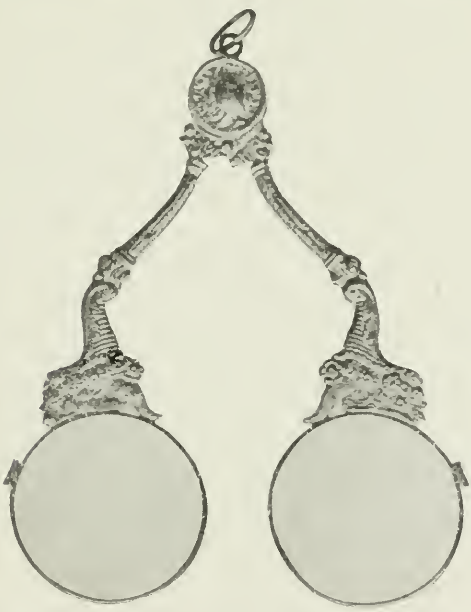


Two Improved Models with Semi-Elastic Springs. (After Greeff.)

arms holding a pair of glasses, which may be supposed to belong to his father Joseph, the elderly man in the background, Greeff (*Zeitsch.*



Glasses with Hinge Joint, to Fold One over the Other. (After Greeff.)

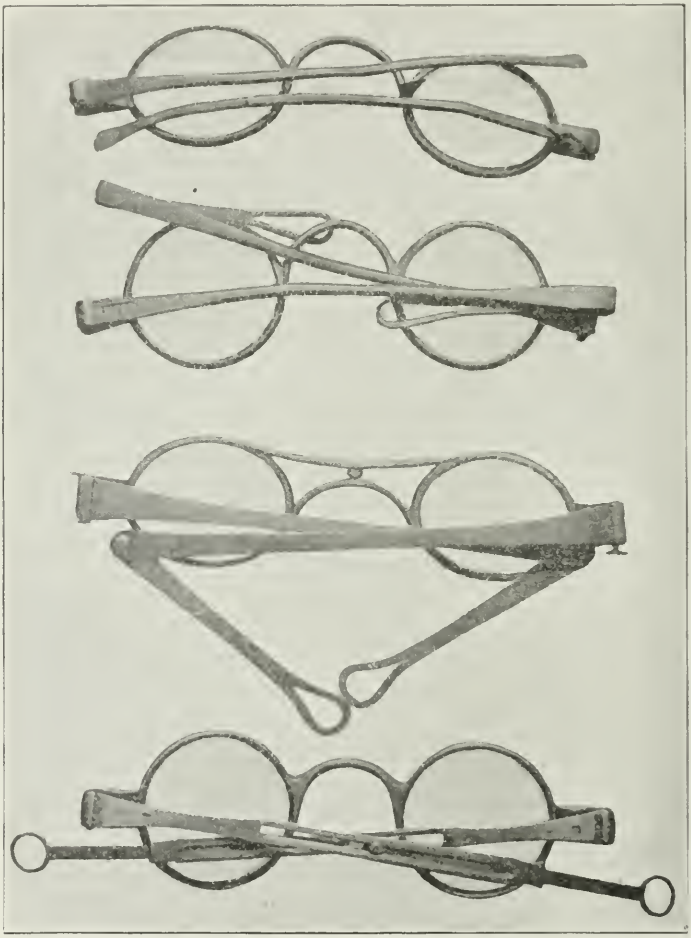


Prototype of the Modern Lorgnette. (After Greeff.)

für Opthal. Optik, August, 1913). Saint Jerome, patron saint of the optician's guilds, is usually represented with glasses.

In place of the solid bow the substitution of a jointed band of

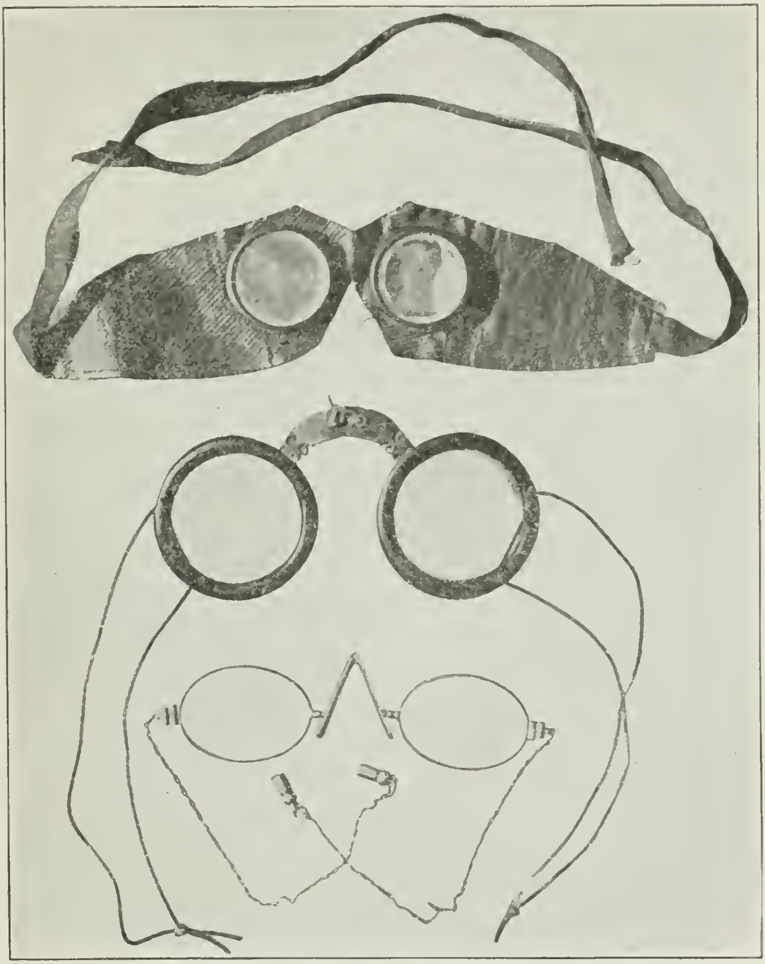
metal was a distinct improvement. This allowed the lenses to be separated or drawn closer together, according to the width of the nose, and so to clasp the nose with additional security. A further convenience was a hinge joint in the connecting bow, allowing the lenses



Early Spectacles. (After Greeff.)

to fold one over the other, so as to fit into a small case. Iron, silver, gold, wood, bone, ivory, horn and leather were used for frames. These were of natural color or polished, and sometimes highly ornamented by carving and filigree work. But few of the early lenses have been preserved, the old frames to be seen in the museums usually being

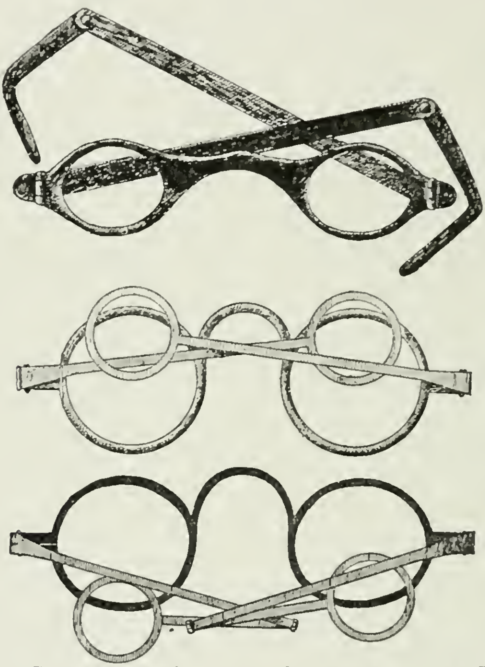
devoid of lenses. They were made of rock-crystal, topaz, emerald, in fact any fairly transparent stone. A variety of such stones were formerly termed beryl (Latin "berillus," French "bericle," German "parille" and later "brille").



Transitions Between Eyeglasses and Spectacles. (After Greeff.)

Greeff (*Bericht der 39th. Heidelberg. Ophthalmolog. Gesell.*, 1913) has depicted the evolution of glasses from the earliest crude type of rimmed eyeglasses with a heavy inflexible bar to the modern graceful and comfortable devices. The insecurity of the primitive forms led to the gradual development of methods to fix the glasses on the

nose. First a nail united the two halves of the iron connecting rod, allowing a little motion. This type was widespread in the fourteenth century. Later more elastic materials were substituted until something comparable to the spring of the modern eyeglass was invented. From a type with two long handles, one attached to each rim and joined below, was evolved the French binocle, and finally the modern lorgnette (19th century).



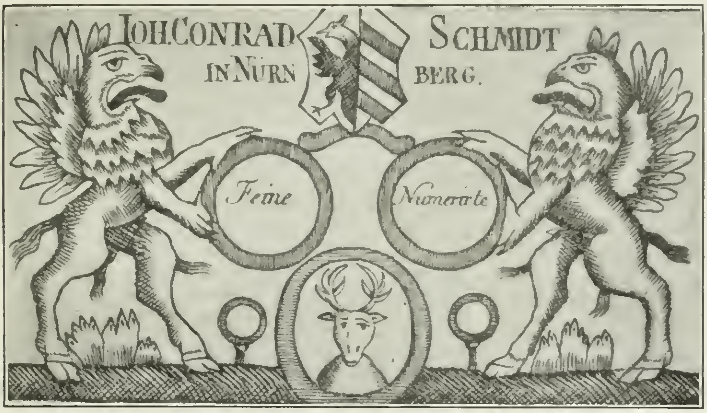
Transitions Between Eyeglasses and Spectacles. (After Pergeus.)

It is likely that grosser hyperopic defects soon received relief after the first era of the use of lenses to correct presbyopia alone. Not until the early sixteenth century did concave lenses for the correction of myopia come into use. The earliest picture showing them is the portrait of Pope Leo X, by Raphael (1517) in the Palazzo Pitti in Florence. The concavity of the lens is well shown by the reflex. It is related that Leo X was a successful huntsman and boasted of seeing better than his companions despite his nearsightedness.

Cataract glasses are mentioned in 1623 by Daca de Valdes.

In France the clergy were the first makers of glasses. Later came the era of guilds which controlled this industry along with many others. As early as 1465 the Spectacle Makers' Guild took part in

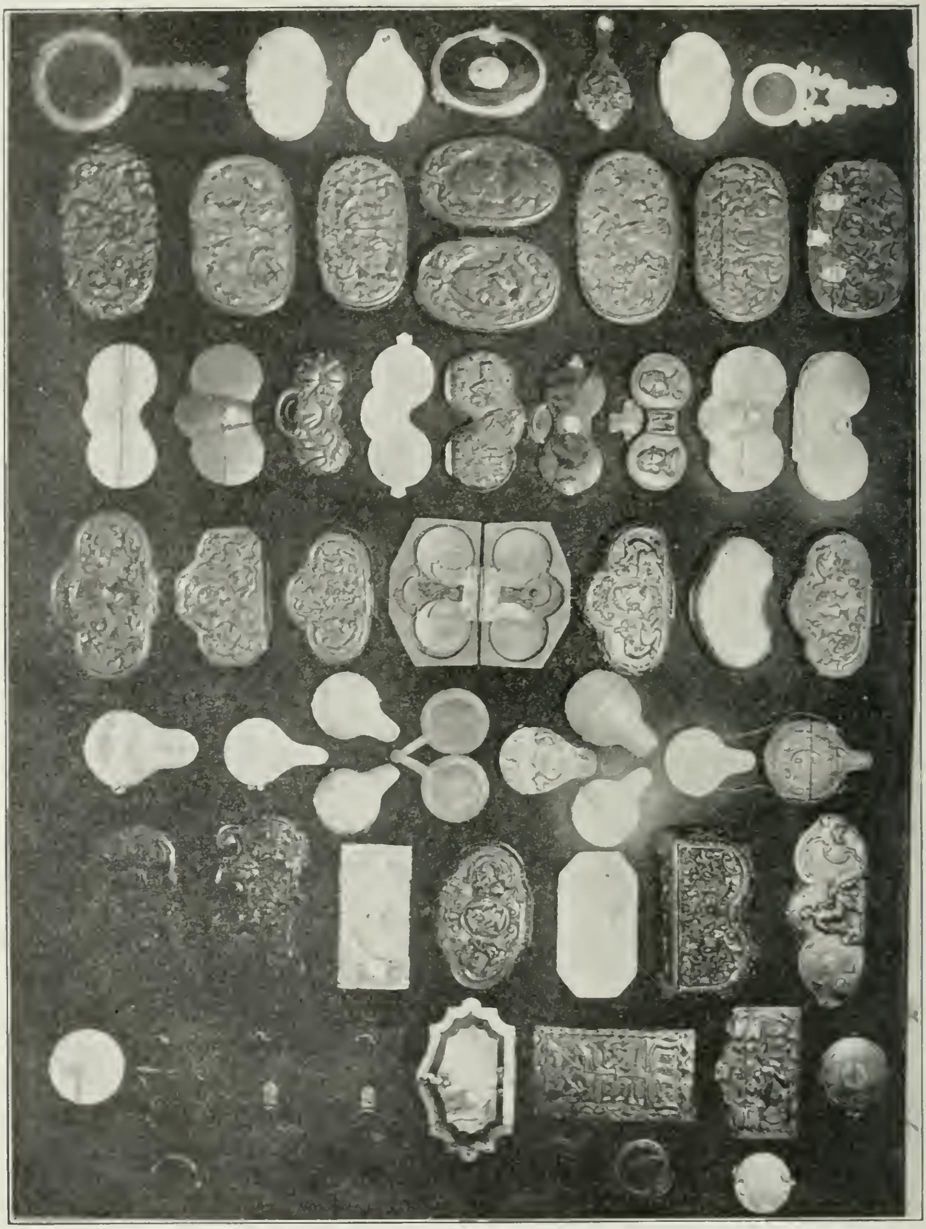
a review of merchants and craftsmen before the French king. This organization survived until abolished by the French government in 1785. Mention is made of the Spectacle Makers' Guild in England in 1563, and several charters were granted to opticians by Charles I and Charles II. With the doing away with guilds, peddlers became the chief source of glasses for the general public. They traveled through the land selling their imperfect wares to those who might select convex or concave lenses for the grosser defects of presbyopia, hyperopia, or myopia. It was only in the later years of the seventeenth century in Europe and the beginning of the eighteenth century in America that opticians' stores became numerous. Previous



From the Original Copper Plate in the Collection of von Pflugk in Dresden.

to the days of scientific concern with refraction by the medical profession only a few reputable opticians succeeded. Notable among these were the historical firms of Nuremberg, which interesting city now contains the most valuable collection of old glasses. Here worked successive generations of opticians whose names are preserved on copper plates from which their letter heads and advertisements were made. The famous Schmidt family have been opticians in Nuremberg from 1634 to the present time. Paul Belgrad, Paul Egrad, Gottlieb Schaab and Hermann Gunt are among the names associated, during the eighteenth and nineteenth centuries, with the optical industry in Nuremberg.

The cases designed for old glasses are interesting examples of the handicraft of the times. They were of many shapes and sizes, generally bulky, and varied in style from plain leather to the most costly creations in metal with elaborate ornamentation of gold, silver and



Old Eyeglass Cases. (From the collection of Madame Heyman in Paris. After E. C. Bull.)

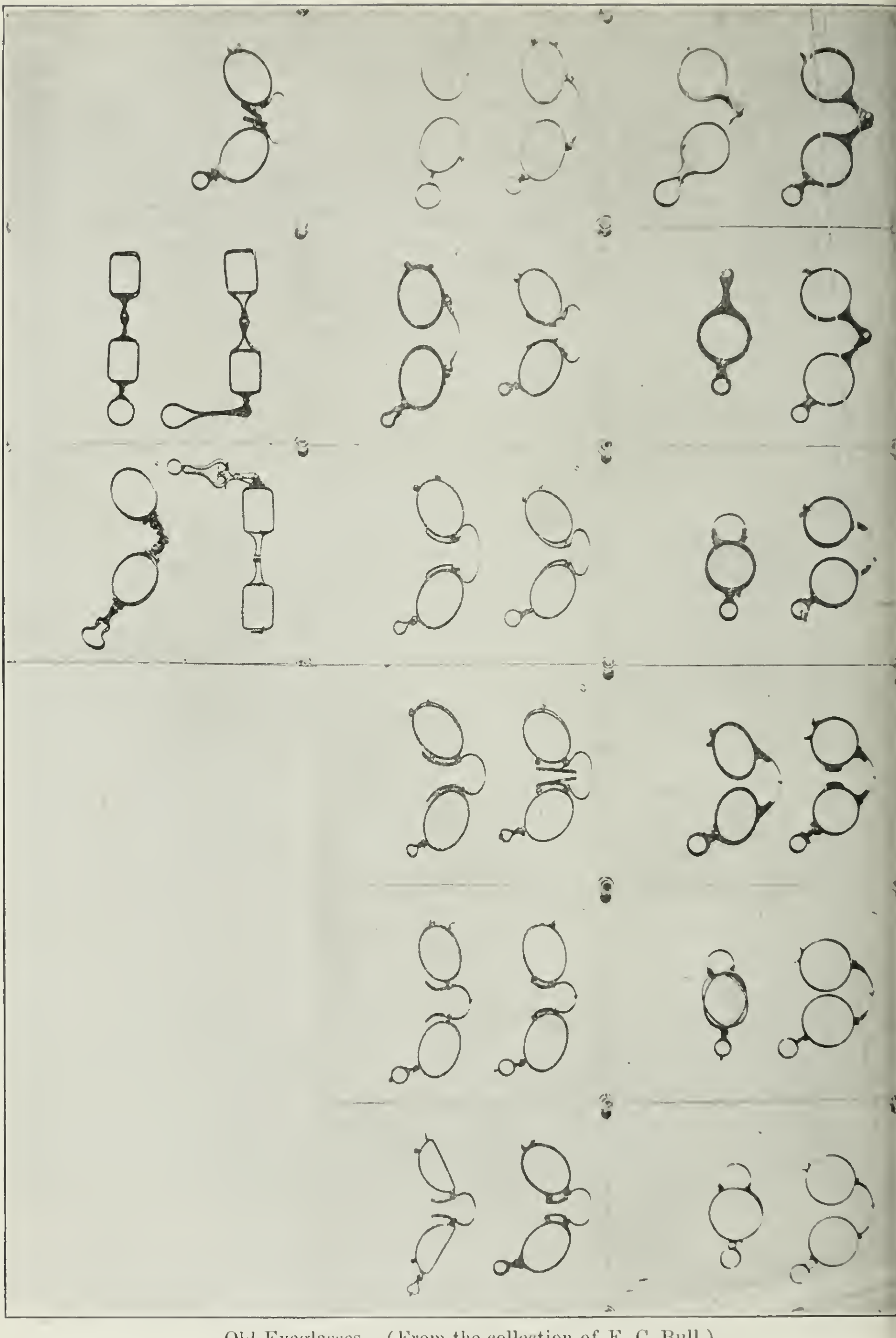
precious stones. The largest collections of these old cases are those of the Nuremberg Museum and of Madam Heyman in Paris.

Excepting the Chinese, it is to be noted that, though the terms "spectacles" and "spectacle makers" were used in earlier times, it was not until the eighteenth century that spectacles in the modern sense of the word, as opposed to eyeglasses, were devised. Through transition forms the evolution of the comfortable and secure spectacles

Very Early Spectacles. (From E. C. Bull's private collection.)

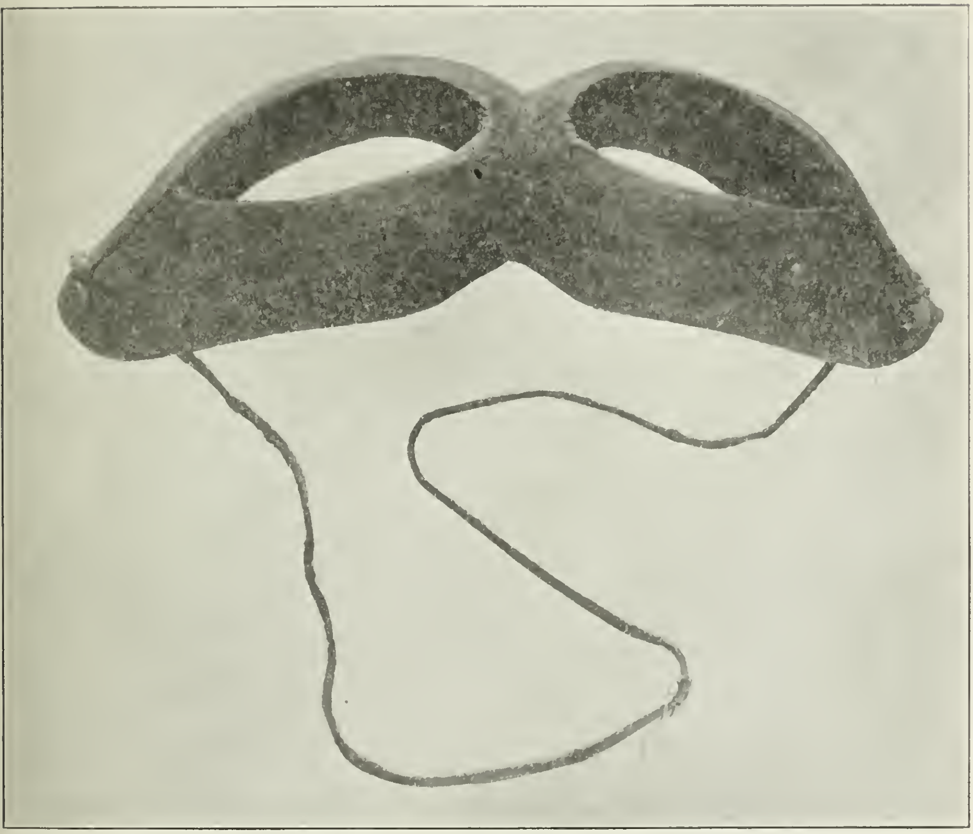
of today can be traced and only quite recently have eyeglasses attained any such degree of perfection with the aid of clever mechanical contrivances. Thus the sequence is seen to be: crude eyeglasses, transition forms, crude spectacles, perfected spectacles, perfected eyeglasses.

In 1746 the optician Thomin, of Paris, advertised glasses which "allow free breathing." In 1752 Ayscough, a London optician, made spectacles. The first models had short temples ending in a plate or ring in front of the ears; next the temples reached behind the ears pressing against the occiput, or were united by threads tied behind



Old Eyeglasses. (From the collection of E. C. Bull.)

the occiput; next a joint was added with a short piece of metal extending from the horizontal temple down behind the ear. This vertical piece was also curved conforming to the curve of the ear. Straight temples continued in favor until very recent times and are used today by a few individuals, although the solid temple of one piece sufficiently



Eskimo Snow Goggles. (From the collection in the U. S. National Museum, Washington, D. C.)

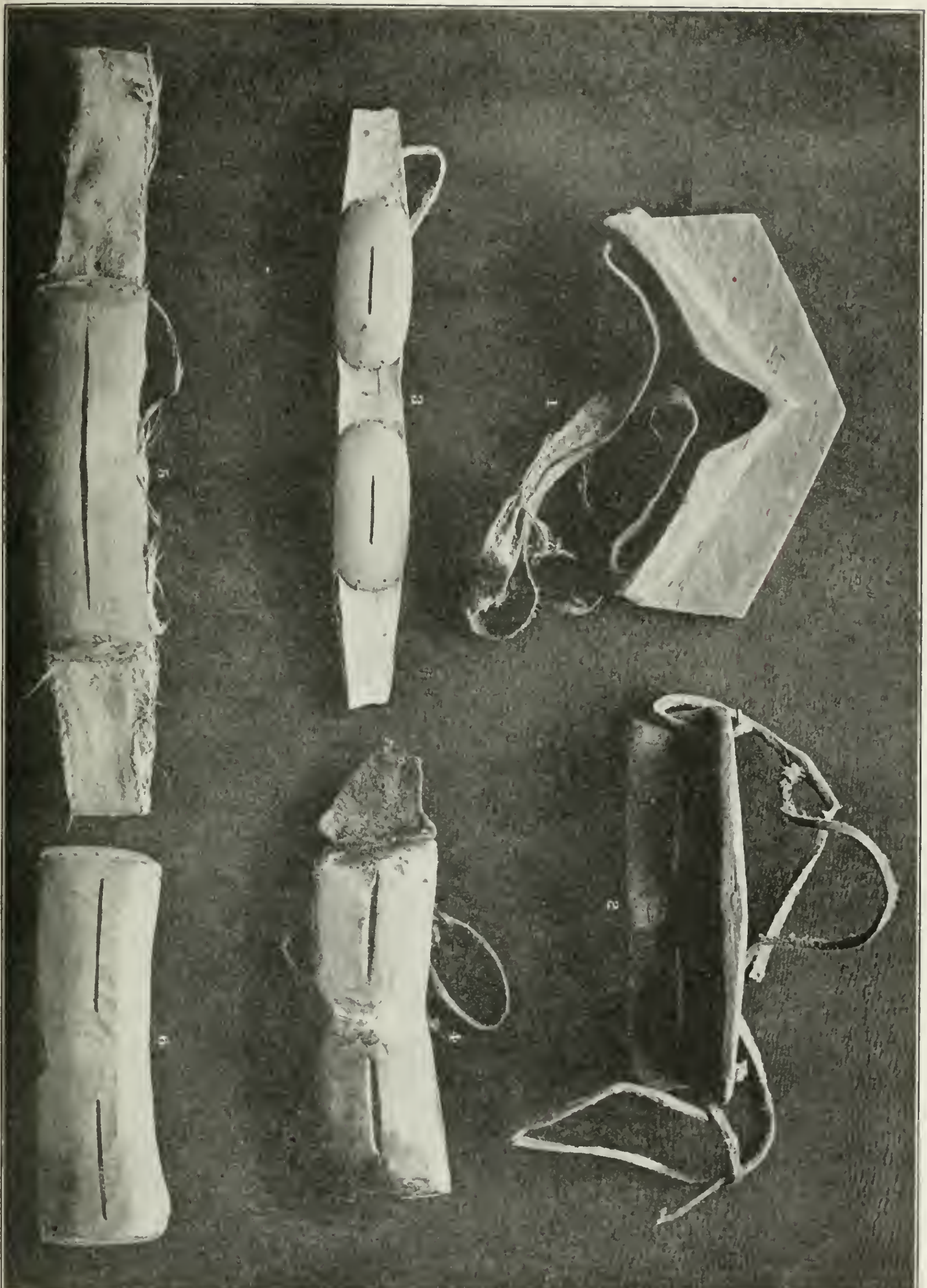
flexible to allow accurate adjustment to the contour of the ear has largely superseded all the older models.

An important function of glasses has long been that of protecting the eyes from excessive light. How far into antiquity this conception goes we do not know; but primitive tribes in various parts of the world devised protective goggles before contact with civilization brought knowledge of glass. The Eskimos have long used wooden goggles hollowed out to fit over the eyes and attached behind the head

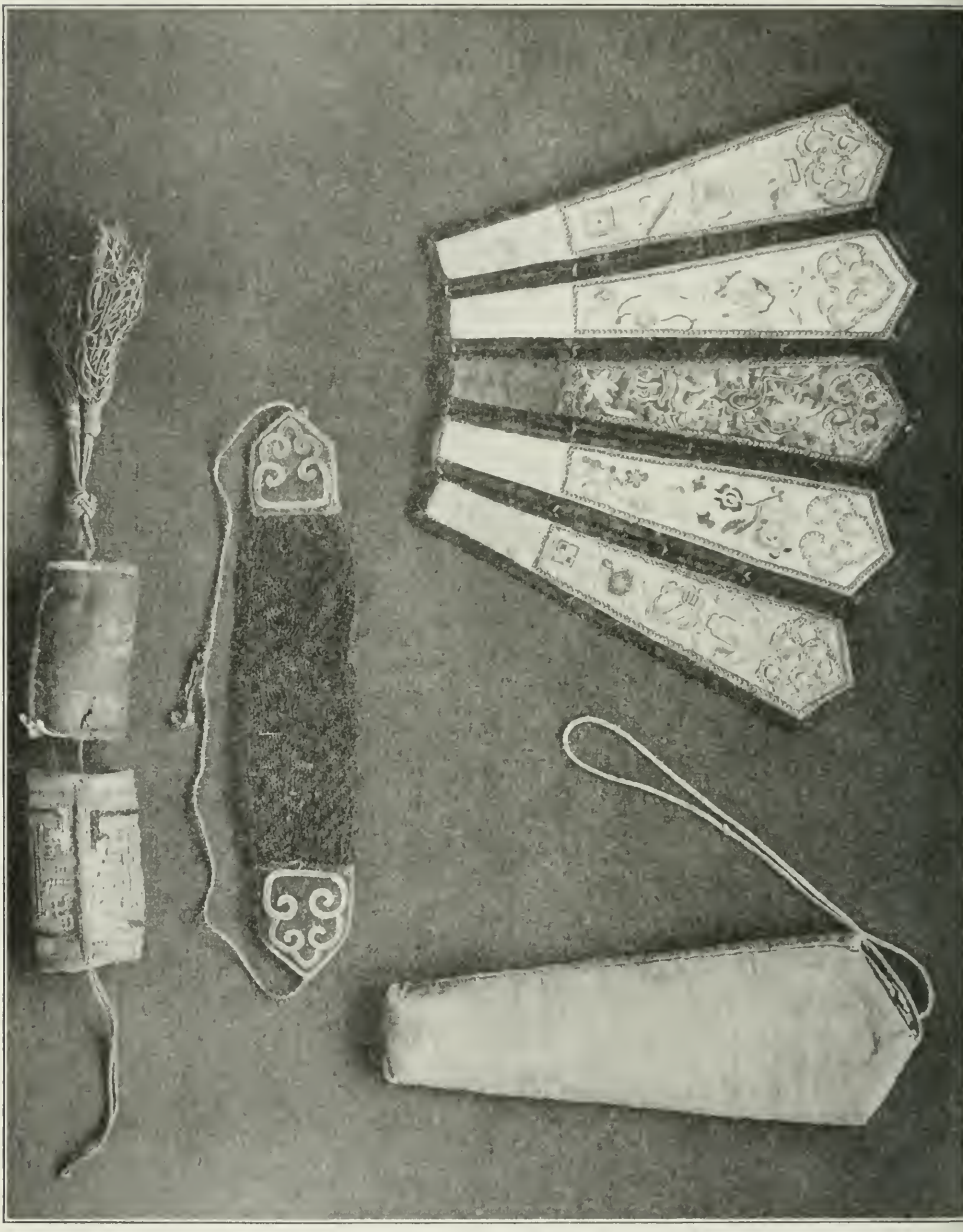
by strings of leather or sinew. Small round holes or slits served to admit a minimum of light while the back of the wood was darkened with smoke, black paint or graphite. More light and graceful is the model consisting of two small wooden trays united by a broad band

Eskimo Snow Goggles. (From the collection of the U. S. National Museum, Washington, D. C.)

of dressed hide, rawhide strings fastening the whole to the head. The extensive collection in the National (Smithsonian) Institute in Washington shows these and other variations and improvements marking the contact of the Eskimos, with civilization. Among the Chinese a sort of visor, like the peak of a jockey's cap, has been used as well as goggles. From Tibet come eye shades made of finely woven horsehair and of silk with the ends sewed into bits of embroidered flannel to tie behind the head. A similar Tibetan device is to be seen in the Field



Eskimo Snow Goggles. (From the collection of the U. S. National Museum, Washington, D. C.)



Chinese Visor and Case, and Tibetan Eye Shades. (From the collection of the U. S. National Museum, Washington, D. C.)

Columbian Museum of Natural History in Chicago. This protective shade is identical in shape with the present-day automobile goggles. The drivers of dog sledges in Siberia wear tin protectors with minute perforations to admit light.

Out of the use of minute openings, round and slit-like, in opaque protecting devices before the eyes probably grew the observation that vision could be improved by the stenopeic slit. It has long been known that myopes see better by producing, through the partial closure of the palpebral fissure ("squinting"), a stenopeic slit between the lids. "*Del Duello,*" published in Venice in 1551, recognizes and allows a slit-like opening in the visor for myopes in duelling and in battle. Masks were utilized in the treatment of strabismus for the purpose of forcing the faulty eye to assume a normal position in looking through a small aperture, the location of the apertures varying according as the strabismus was convergent or divergent. Such a mask was used by Ambrose Paré in 1575, and the device was pictured in Bartisch's famous text-book in 1583. Deformed pupils, scarred corneas, nyctalopia, and albinism are mentioned as conditions calling for the mask. (Pergens, "*Die Geschich. der stenop. Brille,*" Hermann Baas *Festschrift, 20th. Abhand. zur Gesch. der Medizin*, 1908.) These minor uses of small apertures for vision naturally disappeared with the advent of lenses for both visual and protective purposes.

Another protective device is the celluloid spectacles manufactured in Stuttgart, Germany. These are white or gray and close-fitting with holes to admit air. They are intended for protection from foreign bodies and from bright light, for which purpose mountain climbers use them. In colors they have been used in testing for ocular muscle palsies and malingering (see Vol. III, page 1924, of this *Encyclopedia*).

Primitive means of escaping the discomfort and harm of glaring light reflected from snow, sand, and water have gradually given way to spectacles containing tinted lenses. Colored glass was made by the ancients; but only in the latter half of the sixteenth century were transparent, colored lenses used for protection against glare. In the seventeenth century Venice was the source of most of the colored glass. E. E. Schreiner, of New York, has investigated this subject (*Short History of Colored Glass and Lenses from 1561 to 1913*). He finds that the earliest reference is to green lenses manufactured in 1561 by Ancott, of Middlesex County, England. In 1672, Pierson, of London, sold blue glasses. In 1767, George Adams, of London, advertised smoke glass under the name of "gray." The first American record is an old advertisement of one James Peters, of Philadelphia, an-

nouncing white, green, blue, and gray lenses for sale. Amber lenses were made by George and Elias Solomons, opticians of Bedford Square, England, in the year 1832. Chevalier, of Paris, in 1873, used two plates of glass, one dark blue and the other dark smoke, which he called "Electric." In 1880 the chlorophyll green lens was made by Fargier, of Paris, who claimed for it the property of absorbing ultra-violet rays. In 1885 William Thompson, of Philadelphia, proposed the amethyst glass obtained from windows tinted by long exposure.

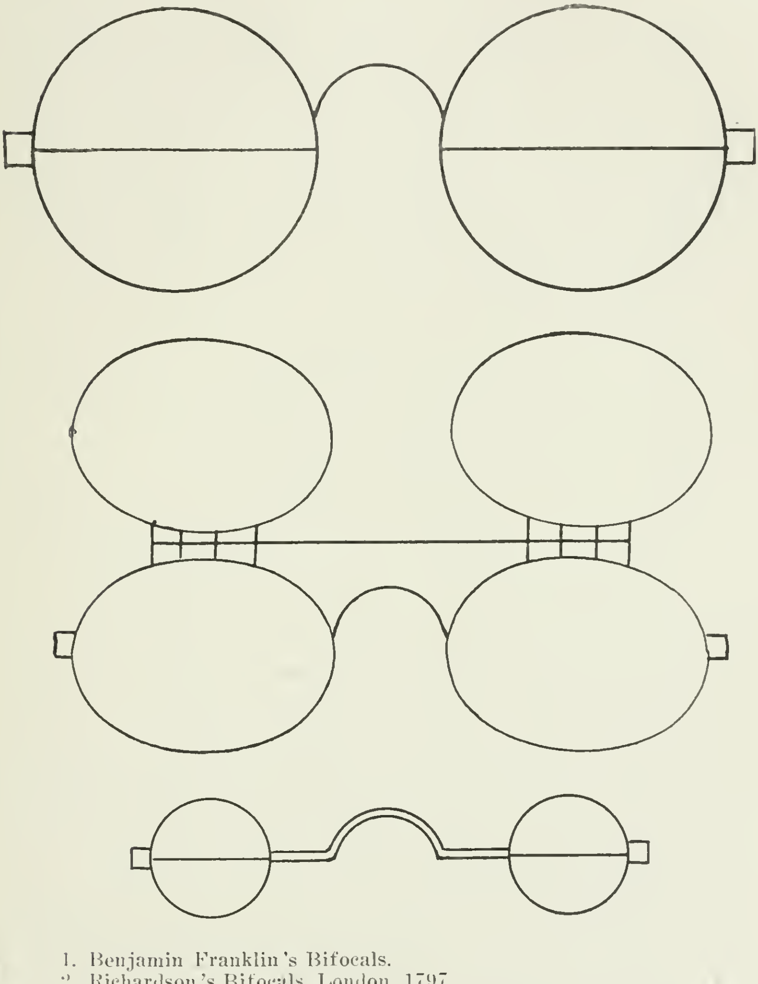
Conditions of life previous to the eighteenth century rendered the use of glasses unnecessary to the majority of individuals and their costliness was frequently prohibitive. The ability to read and write was the possession of the learned few and no adequate appreciation of optical principles had arisen save in the minds of a few scientists following Kepler's observations (1604). Glasses were highly valued by their wealthy possessors. In 1379 the will of Charles V., of France, bequeathed two pairs of glasses, one with black horn rims and a wooden handle, one of gold with a large silver case weighing ten pounds. Frederick the Great is said to have had Hieronymus Meyer come to Frankfort to make him a pair of glasses. Napoleon I had a "binocle" of mother of pearl with branches of gold, the lenses being made of rock crystal.

Such luxuries were caricatured by Hogarth in England, and in France in the time of the Directorate. Physicians knew little of optics and regarded the prescribing of glasses as beneath their dignity. The famous German ophthalmologist, George Bartisch, in his text book published in 1583, condemned their use severely. Von Arlt, in the nineteenth century, was the first ophthalmologist of note to pay due attention to glasses as a valuable addition to the therapeutic armamentarium of the physician.

In the early nineteenth century a great advance was made in the application of lenses to the correction of errors of refraction, when the English scientist, Thomas Young, demonstrated the condition of astigmatism (1801). Sir David Brewster, of Edinburgh, whose name is mentioned in this connection, belonged to a younger generation and no doubt his experiments were based on Young's previous observations. Sir George Airy was the first individual to receive the benefit of the correction of his astigmatism which he worked out himself and for which the optician Fuller, of Ipswich, England, furnished glasses in 1827. The optical firm of McAllister, of Philadelphia, ground cylindrical lenses in 1829, and it is believed that sphero-cylinders were first ground in America by the optician Zentmayer, of Philadelphia,

who had the distinction of being the first in this country to limit his optical business to the filling of physicians' prescriptions for glasses.

When the factor of "eye strain" based upon astigmatism received

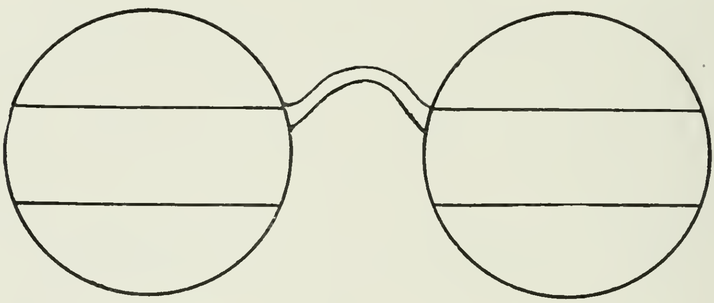


1. Benjamin Franklin's Bifocals.
2. Richardson's Bifocals, London, 1797.
3. Thomas Jefferson's Bifocals, 1806. (After E. C. Bull.)

appreciation, the making of glasses rapidly became an important industry ministering to the needs of thousands who were unconcerned with the optician's art so long as it applied only to the aged and the grossly farsighted and nearsighted individual.

From the time of Roger Bacon to the latter half of the nineteenth

century the evolution of the history of glasses was slow, consistently with the civilization of this period. So long as transportation was difficult and dangerous, books cumbersome and few, education limited to the minority of men and denied altogether to women, and life largely rural with few occupations requiring prolonged use of the eyes at close range, the world in general endured what eye defects nature had inflicted and the fifth decade of life brought the failing of near vision which was accepted along with gray hairs and toothlessness. Johann Kepler's demonstration of the principles of optics was of scientific interest; but the medical profession awaited the ophthalmoscope of Helmholz (1851), the classic work of Donders (*The Refraction and Accommodation of the Eye*, 1864), and pharmacology's gift



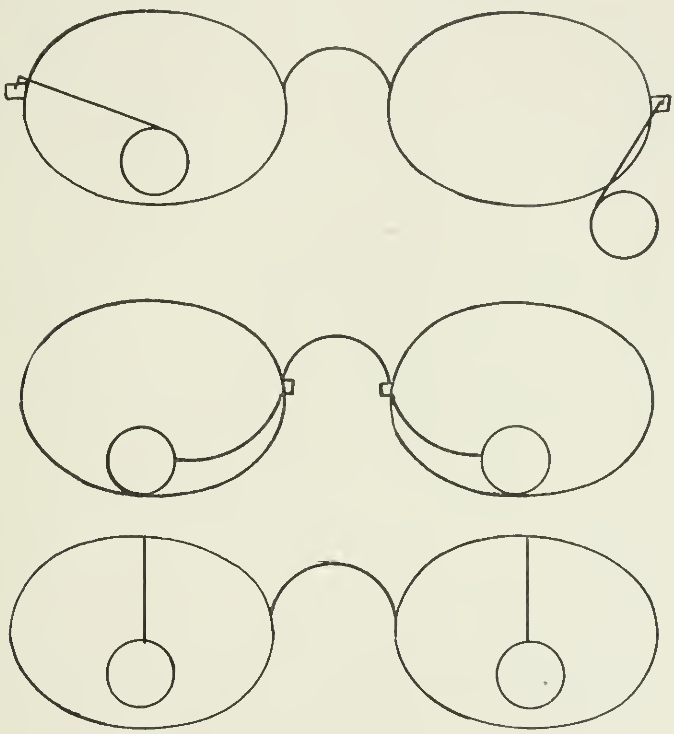
Trifocals of John Isaac Hawkins, London, 1825. (After E. C. Bull.)

of cycloplegic drugs before an accurate refraction and proof of the value of glasses in the relief of eye strain incident to modern conditions of life could be secured. These veritable boons to mankind have relieved suffering, prolonged years of usefulness, forestalled disaster to the entire organism as well as the ocular apparatus, and added to the sum total of human happiness to a degree which it taxes the imagination to conceive.

The origin and early uses of prismatic lenses are unknown. In 1844, Charles Chevalier, of Paris, recommended glasses for the correction of squint. It is possible that he meant prisms, for at that time there was no appreciation of the relationship between errors of refraction and squint, and no practice of the refinements of refraction with the aid of cycloplegics as understood today. In 1865, Dyer called attention to the value of prisms for gymnastic exercise of weak ocular muscles. For the past fifty years prisms have been widely used. Accuracy in refraction has in itself so righted muscular imbalance that prisms are no longer used extensively as part of the correcting

lenses; but as instruments for gymnastic exercise, as tests for malingering, to measure the power of the several extraocular muscles, and to relieve diplopia they have a large place in ophthalmic practice.

The subject of prismatic lenses is treated fully from several standpoints in an article on **Ophthalmic lenses** in a later volume of this *Encyclopedia.*

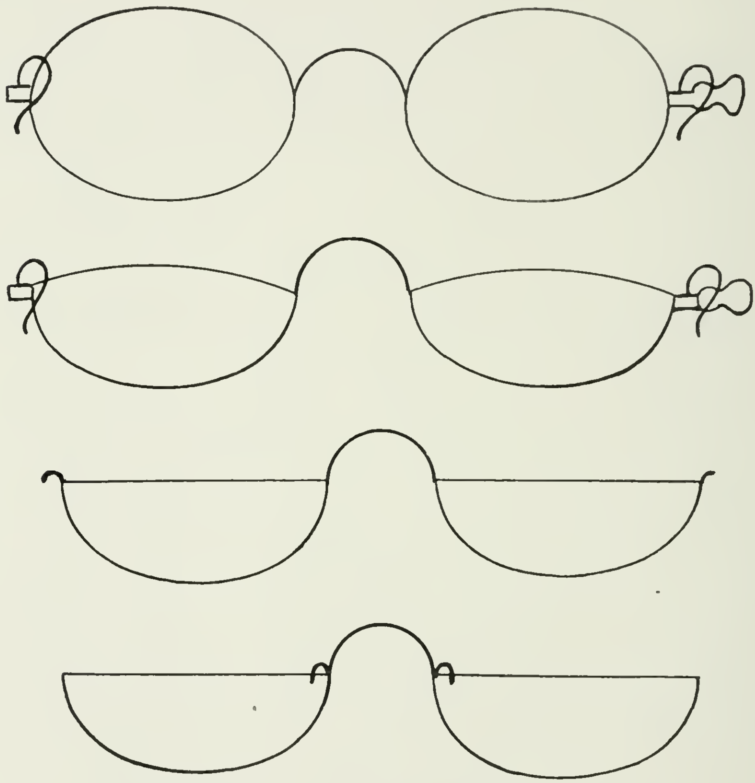


Auxiliary Lenses for Bifocals. (After E. C. Bull.)
1. Butterfield, 1895. 2. Orr, 1896. 3. Taylor, 1898.

The invention of bifocal glasses is credited to Benjamin Franklin in the year 1784. The purpose and results of this convenient arrangement cannot be indicated better than in his own simple statement in a letter (quoted from the *Posthumous Works of Benjamin Franklin*, page 173): "I had two pairs of spectacles that I used alternately because when traveling sometimes I passed the time in reading, sometimes in looking at the country. The change from one pair to another was troublesome and often was not effected soon enough to allow me to see what I wanted. So I had my glasses cut in two halves, one half

of each being put in the same frame. In this way I wear my spectacles constantly, and I have only to look through the upper or through the lower part in order to see distinctly far distant objects or near objects."

Many changes in the bifocal have occurred since Franklin's time. The upper and lower lenses have been separated by a shell rim; the

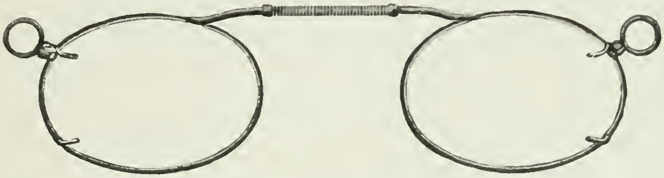


"Grab Fronts" and "Grab Backs." (After E. C. Bull.)

lower lens has been tilted in at the bottom to occupy a better position for reading (an English model of the early nineteenth century); a small segment of the upper lens has been cut out and the reading glass inserted in its place with cement, and later fitted into a groove in the upper lens. In 1826 John Isaac Hawkins, of London, described his invention of trifocal glasses, and E. C. Bull, of Pasadena, California, (to whom the writer is indebted for valuable unpublished notes descriptive of his comprehensive collection of glasses) mentions a

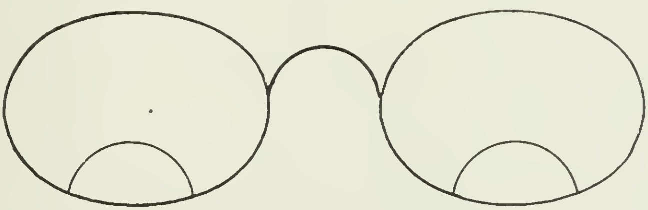
patent of Beetle, of Lyons, for placing in one frame four glasses of different strengths with different inclinations, the four together making segments of a common circle. (See, also, **Franklin, Benjamin.**)

As early as 1836 the effort was made to obtain with one piece of glass the double focus required for near and far seeing. I. Schuster accom-



Grab Front with Bar Spring Bridge.

plished this by grinding off a small portion of the reading lens to give distant vision. Numerous opticians in England and America followed this plan, until eventually we find the exquisite pieces of workmanship to be described later as kryptok and one-piece bifocals. The disadvantage of crude bifocals was that they did not admit of comfort in walking. To obviate this difficulty auxiliary lenses were attached to the frames so as to be withdrawn from the field of vision when the wearer

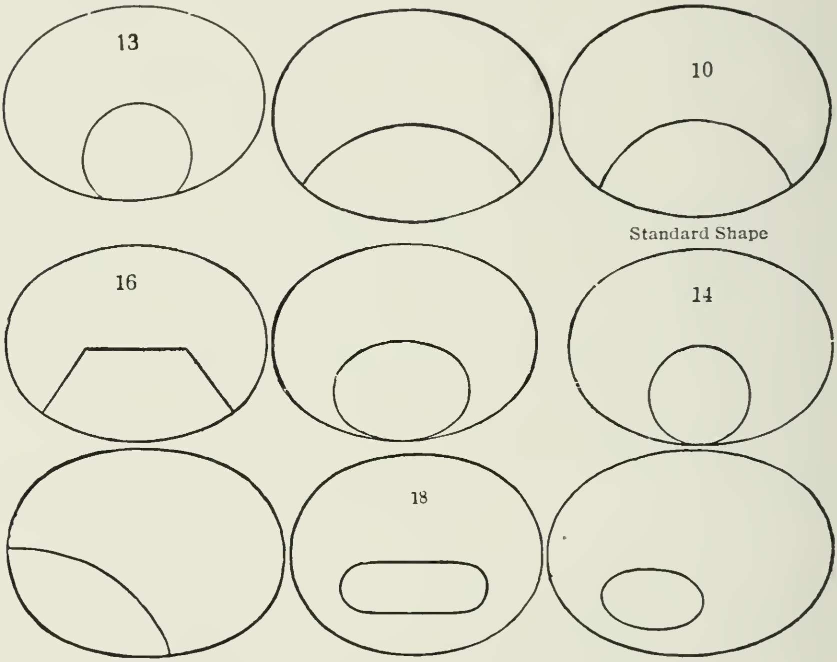


Cement Bifocals of Samuel Gregg, 1866. (After E. C. Bull.)

wished to use distance lenses only, and to be swung into place when he wished to see nearby. Of the numerous models devised, all consist essentially of a short arm pivoted to the temple, bridge, or rim. None of these has attained popularity. Of more frequent use are the "grab-backs" and "grab-fronts" which hook over the end pieces of the temples either behind or in front of the distance glasses.

The most practical bifocal of the two-piece variety and the one commonly used today has the presbyopic correction made by a small segment cemented with balsam to the lower part of the distance glass. This originated with Samuel Gregg in 1866 and was re-invented by several other opticians.

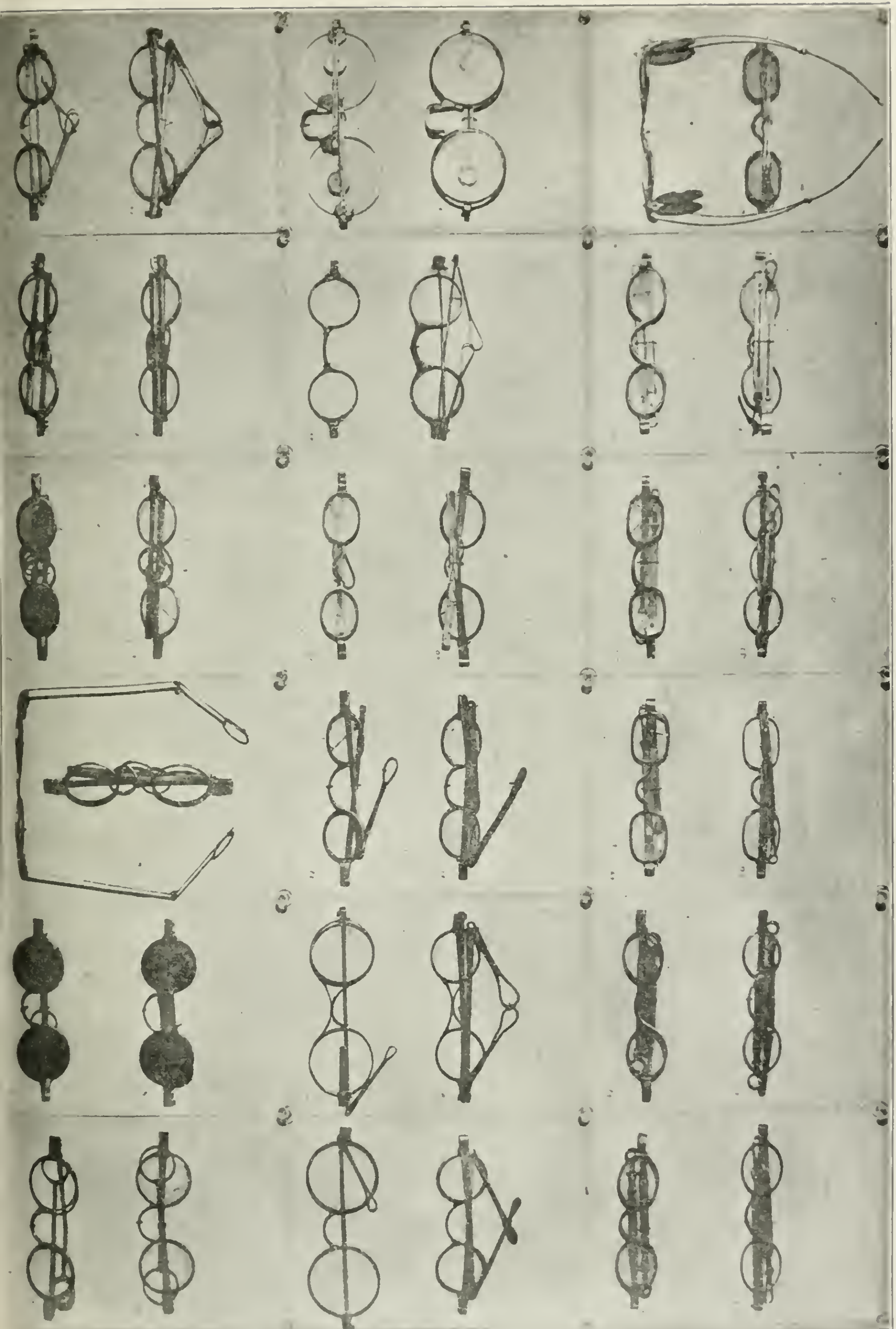
Hogarth's caricatures contained many drawings of eyeglasses but only one of spectacles. This fact suggests that it was about the year 1750 when spectacles came into use in England. As has been stated, the short straight bows gave way to longer jointed bows so that by the end of the seventeenth century something like the primitive Chinese types were in vogue in Europe. The long bows were called "telescope sides" and "turn-pins" according to the mechanism by which they were reduced in length to fit in the case. The long, straight, solid



Cement Bifocal Lenses, with Various Shapes of Segments.

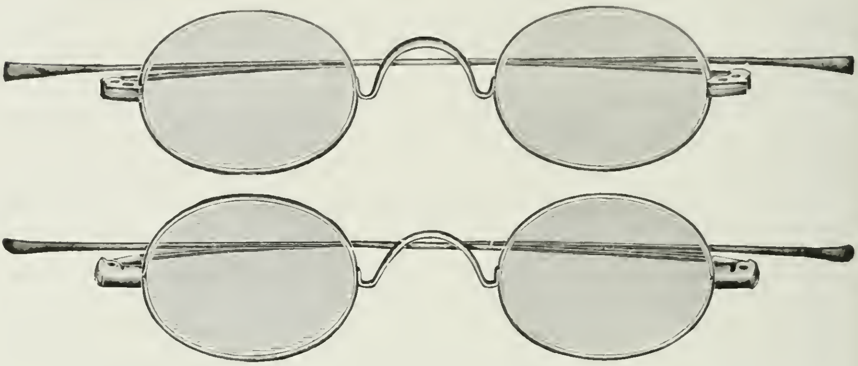
temples worn by George Washington about 1789 are now preserved in Philadelphia.

About the year 1840, Waldstein, of Vienna, devised rimless spectacles, attaching bridge and bows to the lenses by means of clamps and screws in place of the former method of inserting the bevel edge of the lens into a grooved eye-wire. Screws had been used for a long time in the frames, as shown in an old Nuremberg pair made of brass, but holes had not been drilled through the glass. Soldering, as applied to both rimmed and rimless glasses, was not known until the nineteenth century. The rimless form in both eyeglasses and spectacles has become steadily more popular, being lighter and neater, and has largely

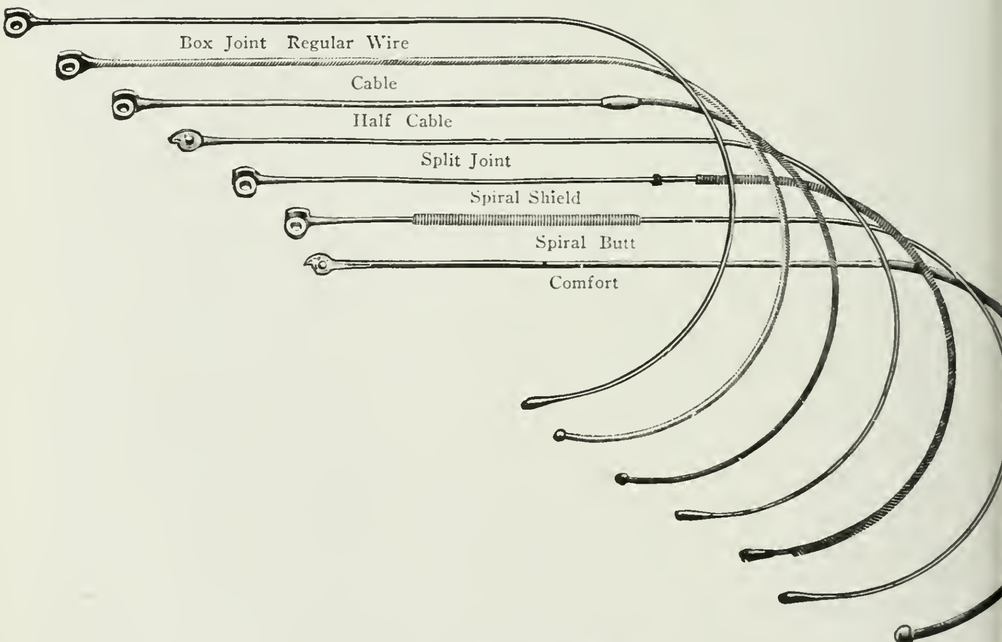


Old Styles of Spectacles. (From the collection of E. C. Bull.)

superseded the rimmed form except for children and for adults whose occupations subject their glasses to rough usage: for the holes drilled



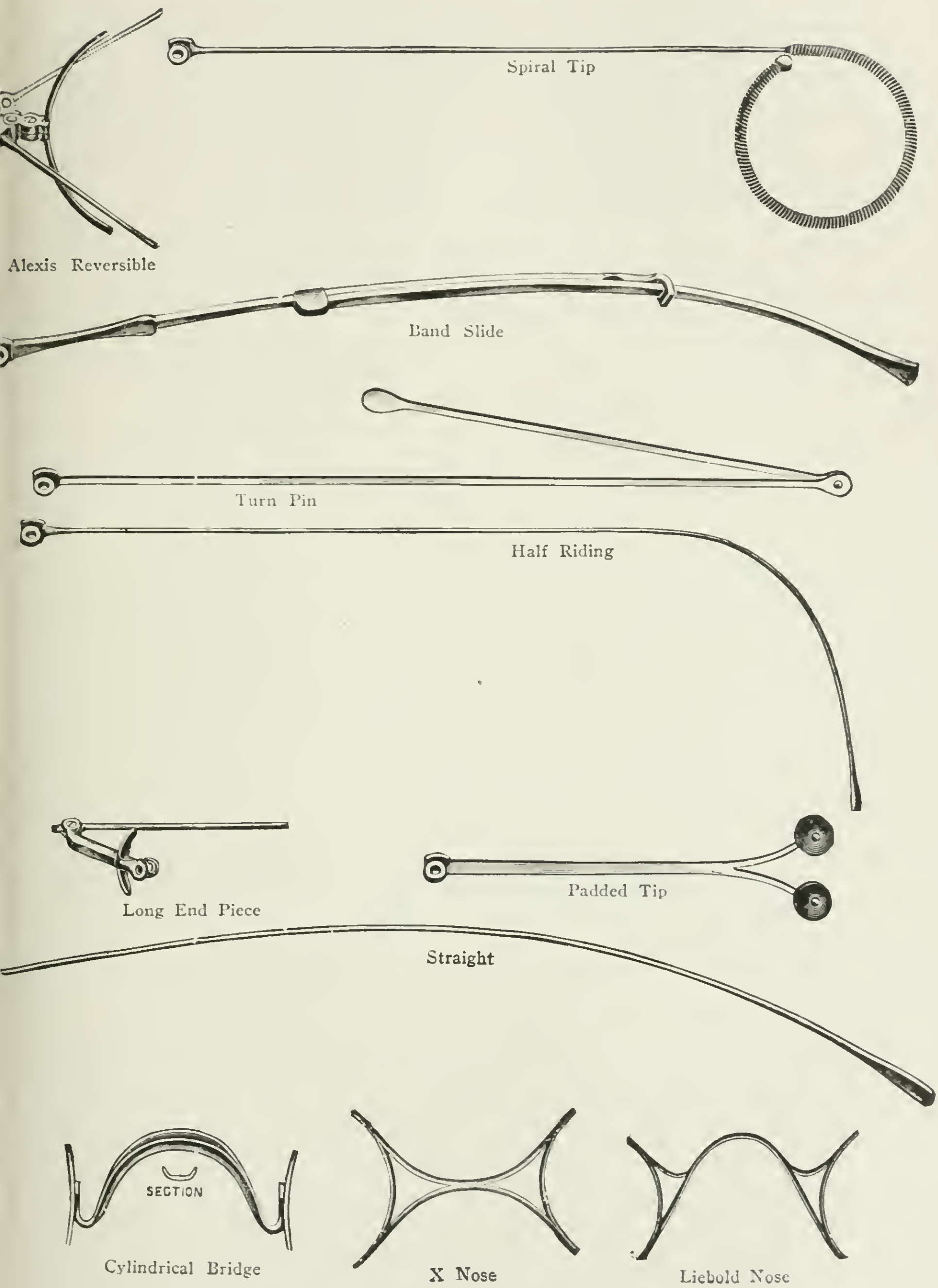
Straight Templed Spectacles.



Spectacle Temples.

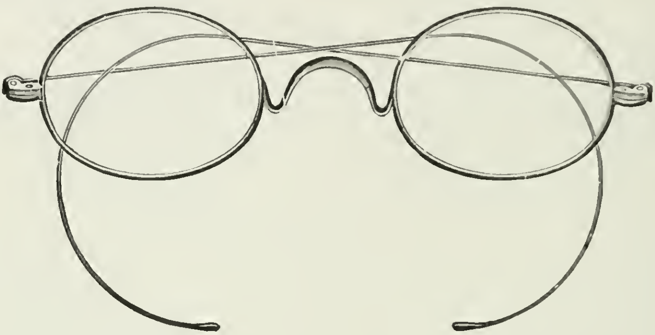
in the lenses of rimless glasses to admit the screws are a source of weakness.

By the year 1850, rimless spectacles with light hook temples appeared in England. These temples, called "riding bows," admit of smooth adjustment to the curve of the back of the ears where they rest with-



Spectacle Temples, End Pieces, and Bridges.

out undue pressure. They vary in flexibility from the stiff 10-carat gold bows to the very soft "cable" and "half cable" and "spirals." The former have the advantage of greater permanence of adjustment; the latter are more agreeable to a hypersensitive skin. The very flexible bows are of value in inverse ratio to the skill exercised in adjusting the stiff and durable bows.



Present Day Riding Bow Spectacles with Saddle Bridge.

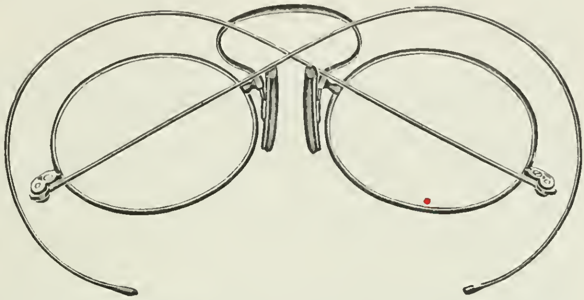
With the substitution of the saddle bridge for the older C-bridge which was used with the straight temples, and the riding bows already described, spectacles have reached the present highly perfected form. The saddle bridge distributes pressure widely and evenly over the bridge of the nose, being capable of infinite variation in angle according to the shape of the nose. It also allows the use of larger lenses than were possible with the C-bridge without altering the pupillary

Eyeglass Guards with Spectacle Bridge.

distance. Contemporary spectacles, therefore, are seen to consist of riding bows connected by a hinge joint with end pieces which are soldered to clamps into which lenses are screwed, and a saddle bridge likewise soldered to clamps to hold the lenses. Rimmed spectacles are devoid of clamps and screws, but have eye-wires into the grooves of which the bevel edge of the lenses fits, bridge and end piece being soldered to the eye-wire.

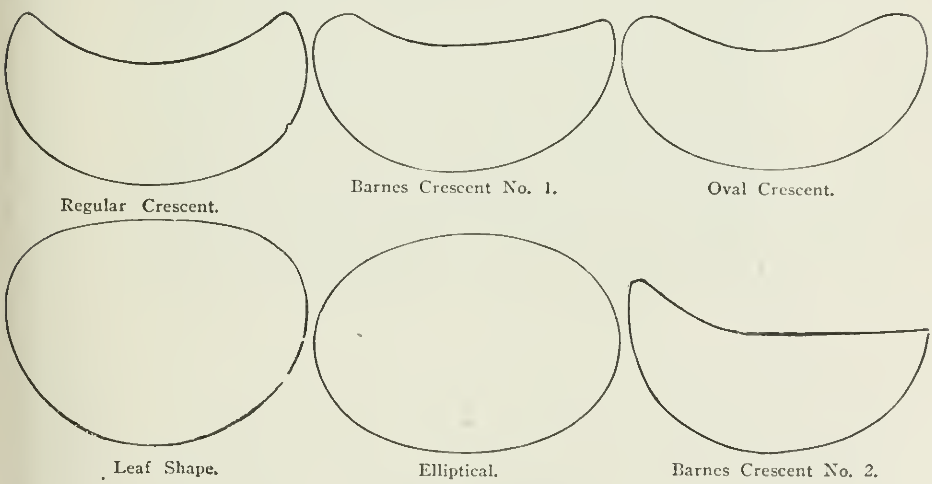
Beyond the fact that early lenses were crude affairs made of semitransparent stone and pebbles, and later of such inferior glass as was

manufactured in Europe, little can be said of the art of making lenses before the nineteenth century. Venice was long the chief source of glass. In 1591 lenses were made by saturating amber in linseed oil, and shortly thereafter colored glasses for protecting the eyes against excessive light came into use.



Combination of Eyeglass Mountings and Spectacle Temples.

Until the nineteenth century large round lenses were made. These were followed by small round lenses which were ridiculed as an affectation. A succession of shapes became popular; namely octagonal, quadrilateral, square, and finally oval. At first the octagonal form



Lenses of Odd Shapes.

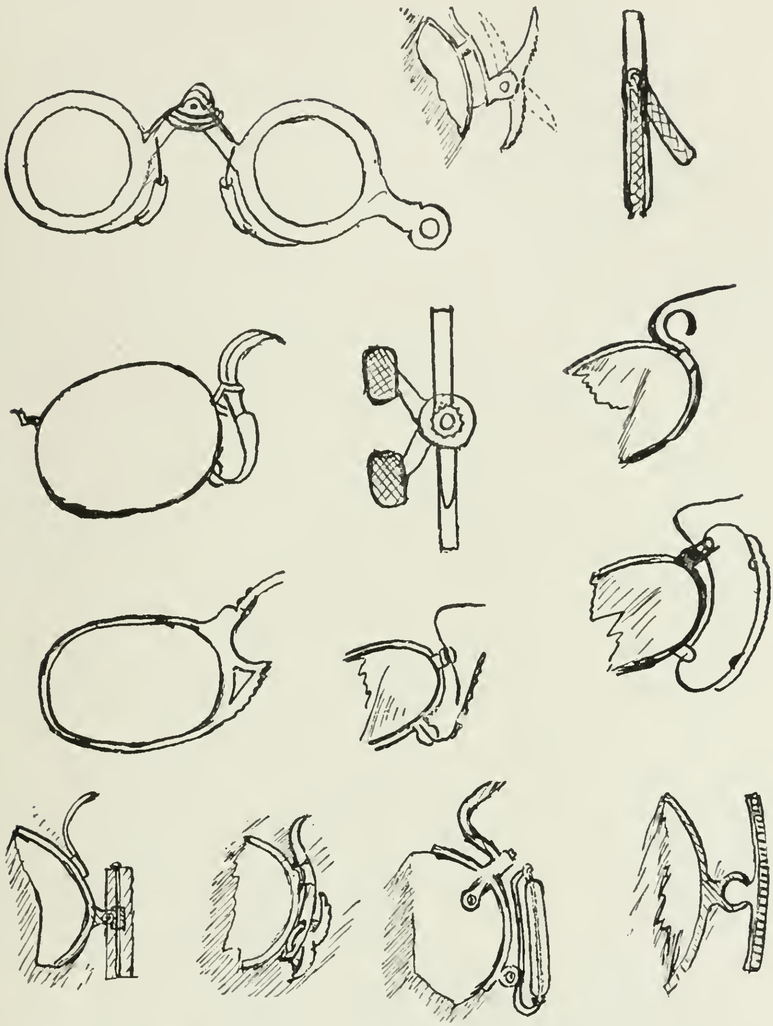
was reserved for cylinders; but later it became the common form for all lenses. At the present time the oval lens is chiefly used. Odd shapes to give a longer vertical diameter, and crescents to allow free distant vision over the reading lens, are also seen. Quite recently

large round lenses enclosed in shell or gold rims have become a fad. It is interesting to recall that the same fad existed in France in 1775, as illustrated in the artist Chardin's portrait of himself.

The glass used for lenses is manufactured in Germany. The best is a crown glass made by the famous firms in Jena, Schott und Genossen and Zeiss. The situation is reversed, however, in reference to the mountings designed to hold lenses.

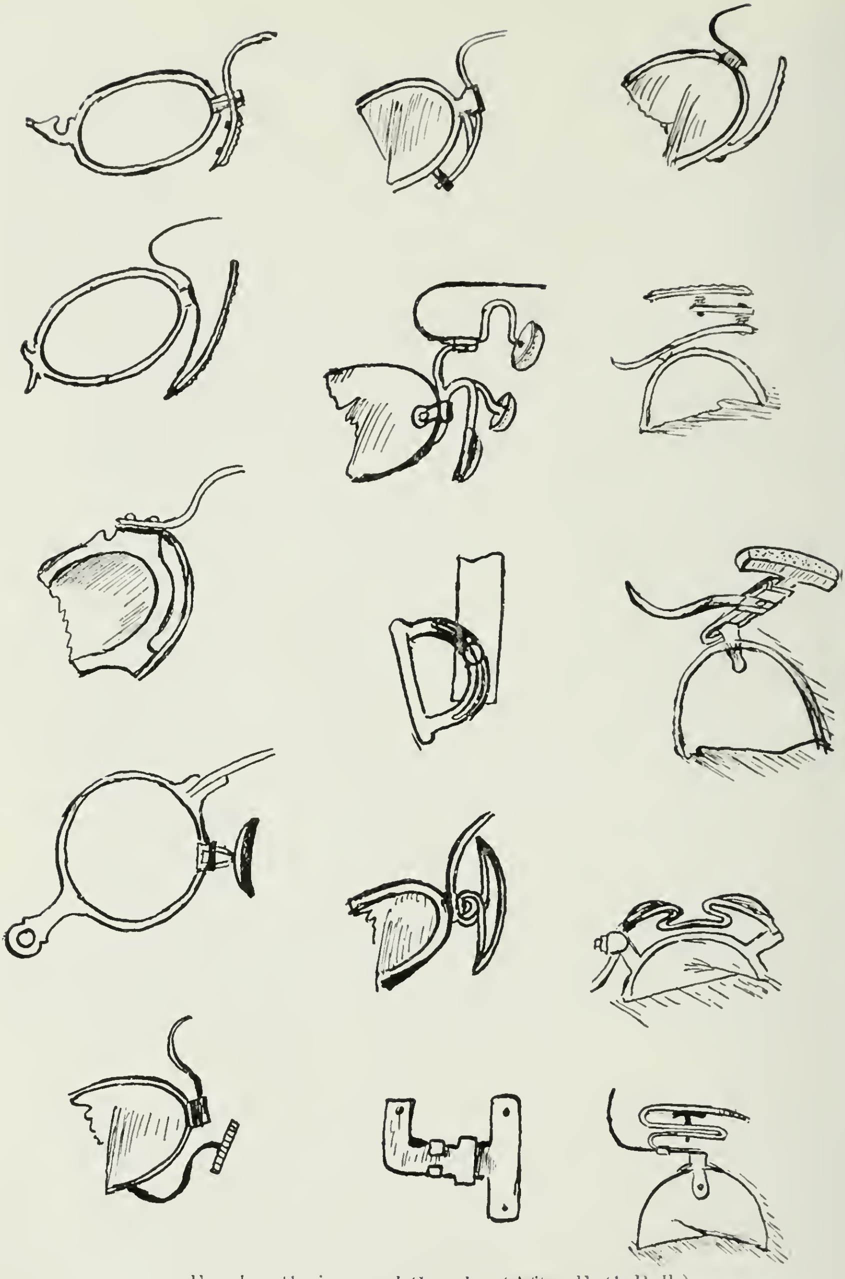
Portrait of the French Artist, Chardin. (By Himself, 1775.)

European glasses were imported in America prior to 1867. From that date, however, the tide has turned until now Europe imports glasses from America. The optical industry in the United States has made rapid progress, so much so that the history of glasses in the past half century is essentially American history. The patents granted in this country since 1870 are legion: many of them are impractical; and many represent so little change from their predecessors that they scarcely deserve mention. One interested in the subject will find unlimited material in the reports of the U. S. Patent Office, from the mass of which several fairly distinct types of glasses may be sifted.



Eyeglass Springs and Guards. (After E. C. Bull.)

J. K. McDonald, 1868.
G. N. Cummings, 1867.
Prentice, N. Y., 1867.
F. P. Jannorone, 1877.
Burbank, 1875.
Boyle, 1896.
G. B. Bridgden, 1875.
Hempler, 1877.
J. W. Hassellund, 1886.
N. Fowler, 1876.
J. P. Michaels, N. Y., 1881.
C. C. Parker, 1875.
Johannes, 1877.



Eyeglass Springs and Guards. (After E. C. Bull.)

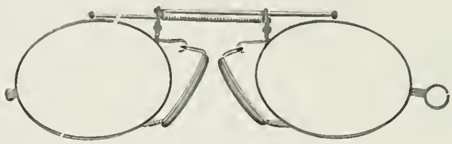
E. Want, 1867.	Peckham, 1875.	E. K. Josselyn, 1867.
J. S. Spencer, 1876.	Walter S. Wells, 1888.	Gilbert, 1886.
J. J. Bausch, 1868.	Beigel.	Levy, 1893.
I. Clements, 1871.	McDowell, 1893.	Opdyke, 1882.
W. Barber. 1879	F. W. McAllister, 1885.	I. Alexander, 1876.

E. C. Bull has made a thorough study of the subject of American glasses and presents the development of the industry in a series of contributions to the *Optical Journal.* He considers the year 1867 noteworthy as the date of numerous important inventions. Cummings, of Providence, R. I., attached the lower part of a bow spring to the eye-wire and to the upper part of the eye-wire a loop through which the bow spring passed. In this way a wide distribution of pressure was obtained. Prentice, of New York, in the same year, made a guard which projected far towards the nose at its top, instead of following the curve of the lens, thus fitting closely the thin part of the nose. This device is perpetuated in the common shell eyeglasses of today. Want, of New Haven, Conn., made a more valuable guard attached only by its upper end to the eye-wire, the entire length being capable of adjustment to the nose. Another invention which had many imitators had the guard attached by its lower end to the eye-wire. In 1868 McDonald, of Newark, N. J., used a soft rubber pad as a guard, attaching it to an older model which harkens back to primitive times; namely, a bridge consisting of two solid bars with a hinge joint to be drawn together by an elastic band. In the same year Bausch, of Rochester, N. Y., made an adjustable spring and guard regulated by screws. To him is due the first adjustment of the lenses before the eyes, and to Want is due the first adjustment to the nose.

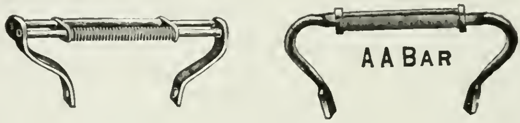
In 1871 Clements invented the first of the self-adjusting guards, the nose-piece oscillating upon a pivot attached to the eye-wire. Further developments of this idea of rocking guards were made by Burbank, of Springfield, Mass. (1875) and others. In 1877 Hempler, of Washington, utilized a curved arm traveling down from the eye-wire through the center of which was a hole and at the lower end a slot. A loop passed through the hole and slot and was attached to the main guard which had considerable vertical play. In the same year a ball and socket rocking guard was made by Johannes, of Washington. In 1886 Gilbert, of Philadelphia, utilized pivoted links as a guard, and Hassalund made a guard with two pivoted centres which allowed a variety of movements in comformity with the shape of the nose.

With a view to limiting the movement of the lenses, several devices were offered in which the guard moves upon a spring of its own. Brigden and Brachett had a guard attached by its lower end to the eye-wire and by its center to a small spring connected with the post. Peckham, of Big Spring, Kas., improved this idea by attaching a guard by means of a post to the top of the eye-wire and allowing it to pass through a loop near its lower end; a supplementary spring passed

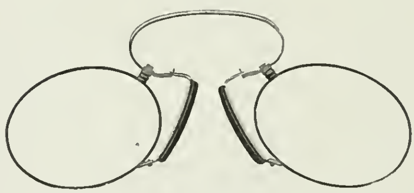
beneath the guard and pressed it in towards the nose. Bausch perfected, in 1875, a form with a guard placed on a light spring attached at its lower end to the eye-wire and having at its upper end a sliding attachment to hold it in position. This was the forerunner of the popular Galezowsky model. Alexander, of Washington, used a set screw to adjust the guard. Barber, of Philadelphia, used an S-shaped



Double-Bar Spring Eyeglass.



Bar Springs.



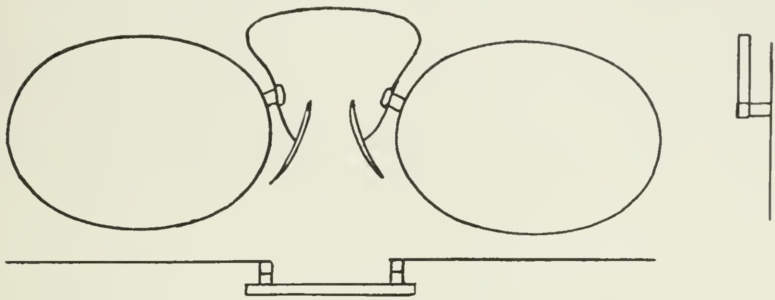
Bausch Cork Eyeglass Guard.

Wells' Cork Eyeglass Guard with Hoop Spring.

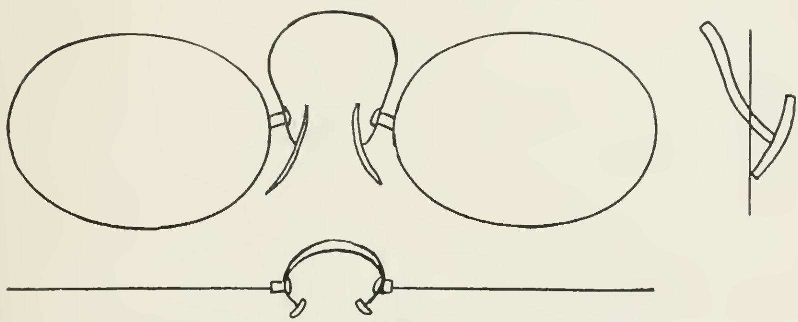
spring attached to the lower part of the eye-wire by one end and bearing on the other end a disk or pad to rest against the nose. Opdyke, of New Haven, had a pad with two bearing surfaces and a curved inlet between, all of one spring. Borsch, of Chicago, in 1895, brought out several guards leading to his important "Anatomical" guard which remains one of the valuable devices today. This con-

sists of a rigid offset guard with an auxiliary guard constituted by a light spring rigidly attached at the bottom of the main guard, running up the outer surface of the latter and attached at right angles to a short arm which passes through a slit in the main guard at its top and joins a small disk on the inner aspect of the guard. This disk exerts slight pressure and prevents tilting and slipping of the main guard.

Various patents have been secured for devices which permit of the adjustment of the lenses before the eyes. A rubber pad was made



Hopkins' Eyeglasses, 1880. (After E. C. Bull.)

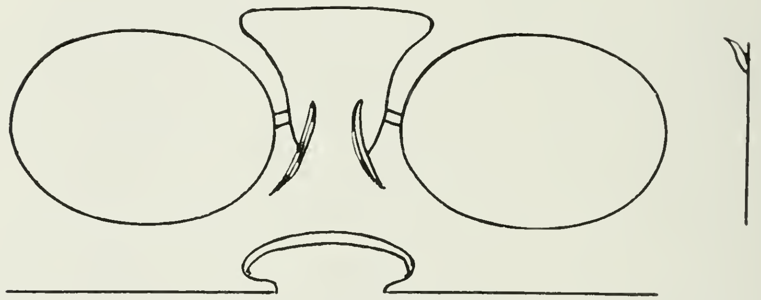


Meyrowitz's Eyeglasses, 1886. (After E. C. Bull.)

with an adjustable pin running through it, whereby the glasses were lowered or raised before the eyes (Johannes, of Washington, 1887). Another device permitted the extension of the glasses forwards to escape the lashes by sliding the guards backwards (McAllister, of Philadelphia. 1885). Meyrowitz, of New York, in 1887, invented the "Champion" clip, allowing a tilting of the glasses for reading. Further improvements resulted in his pivot guard. This form admits of considerable adaptation to the nose by virtue of the attachment of the arm rigidly at the bottom of the guard while pivoted at its center,

the arm being sufficiently flexible to change its shape with the adjustment of the guard (see illustration of modern eyeglass guards).

A disadvantage of the earlier devices was that the guards, being in the plane of the lenses, necessarily rested forward on the thicker part of the nose. To prevent this, Ivan Fox, of Philadelphia, in 1884, devised his offset guard, the most noteworthy single achievement in the art of adapting eyeglass mountings to the individual nose, and a distinctly American conception. European glasses meet the needs of an average nose—a thing rarely found. The Fox guard allows exact adjustment to that portion of the nose where security is consistent with a minimum of pressure. This is accomplished by a single piece of metal the blade of which has a bearing surface of shell or cork, attached to the post by means of a shank running back of the plane of the lenses. Thus the guards fit high up and back on the thin portion of



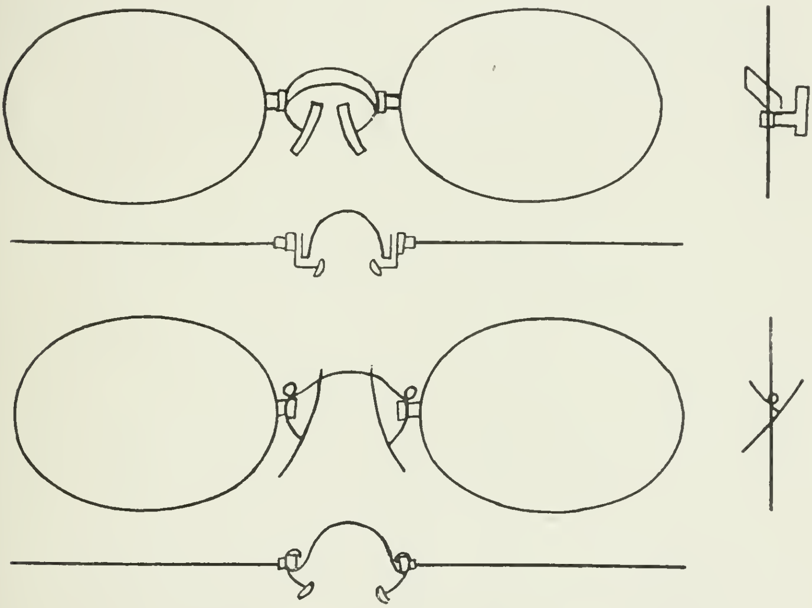
Eyeglass of Fox and Brown of Philadelphia, 1888. (After E. C. Bull.)

the nose close beneath the brow. This invention was popularized by Kerstein after a period of neglect due to objection to an eyeglass which could not be folded together and placed in a small pocket case. It finally became evident that the convenience of such a folding eyeglass was not to be weighed against the disadvantage of weakening the spring, scratching the lenses, and throwing them out of alignment, as happens when they are folded.

Auxiliary guards have been designed to secure two or more bearing surfaces, in an effort to prevent vibration, hold to the nose more firmly, distribute the weight, and permit of more accurate adjustment. The first models consisted of movable auxiliary guards attached to fixed guards and capable of being rotated out of the way so that the glasses might be folded together; a matter insisted upon by opticians and public long after its harmfulness should have been realized. Wells, of New York, in 1888, invented the first practical model with a disk

on a small arm extending from the main guard. In the following year he added a second arm and disk. Further advances came in the form of the Bausch "Anchor" guard of the Julius King Co., of Chicago, and the "Four-Foot" guard of J. M. Johnston, of Chicago, which are adequately explained in the illustrations. Other examples might be cited different in detail, but all of the same type.

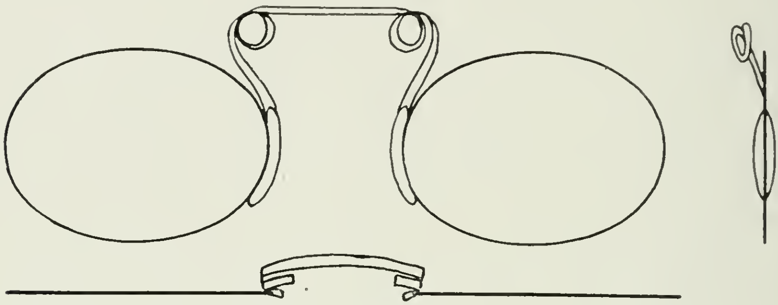
In the matter of eyeglass springs very little advance over the crude medieval models is noted until the nineteenth century. In England as late as 1825 the bridge was heavy and there was no flexibility at



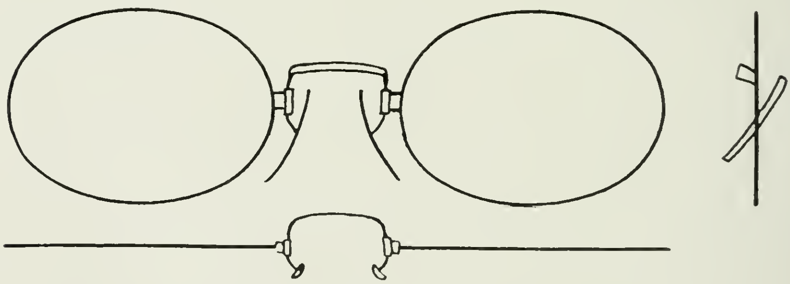
Two Models of Eyeglasses, by Martin of Philadelphia, 1889. (After E. C. Bull.)

the ends. In France in 1839 coiled springs were used and the bridge portion was of light weight. Further improvement came from America where Cadman, in 1872, made a horizontal band-spring with pads projecting backwards against the sides of the nose. In 1880 Hopkins, of New York, devised a horizontal projection from the eyeglass to be attached to a vertical spring. E. B. Meyrowitz, in 1886, made a spring to slant forwards escaping contact with the brow; this was called the "tilting spring." In 1888, Edward Fox and D. V. Brown, of Philadelphia, made the "Grecian Curve" spring. Martin, of Philadelphia, in 1889, used a wire spring with coils near the ends; and

another saddle-shaped band-spring, like that of Meyrowitz, but fitting close to the nose. In 1892 Hempler, of Washington, used two circular turns or spirals at each side of the spring to carry it well forwards from the brows. In 1894 E. C. Bull, then of Paris, made two styles of eyeglass similar to Cadman's and to those of Hardy, of Chicago, and Beckwith, of New York. Heard, of Cincinnati, in 1897, devised a rigid bridge to rest over the nose with arms projecting back and up and back and down, to clasp the nose both above and below; all being



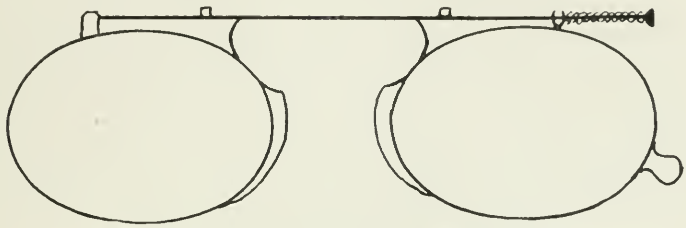
Hempler's Eyeglasses, Washington, 1892. (After E. C. Bull.)



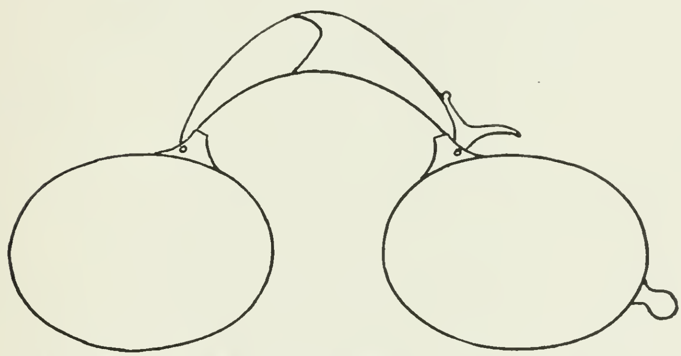
Eyeglasses of E. C. Bull, 1894.

made of one piece of wire. In 1904, Charles H. Pixley, of Chicago, patented a mounting which may be considered the parent of the very popular finger-piece eyeglasses of the present day. He made a saddle bridge of the spectacle type with a shank attached to the lenses without a screw. In the crotch of this bridge on each side an arm was welded which extended downwards curving on itself out and upwards to form a guard which might be padded or not, as desired. From this model, and numerous others devised by Leo F. Adt, of Albany, N. Y., Henry E. Kerstein has developed the "Sure-On" types of today.

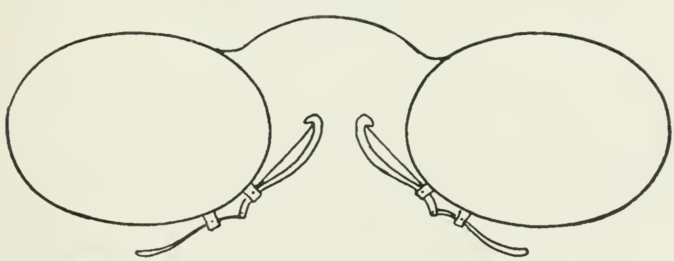
The illustrations of these various models will reveal two distinct tendencies. One was towards an inflexible short bridge crossing the nose in or near the horizontal plane of the lenses; the other was a flexible spring, rising above the level of the lenses, curving in front of



Model of G. C. Hilpert of Hill, N. H., 1880.



Model of George W. Phoenix of New Brunswick, N. J., 1881.



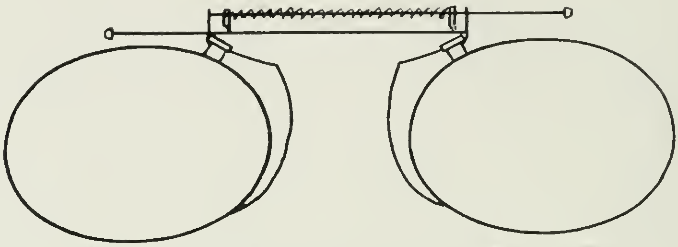
Model of Louis Bityer of Montague, Mass., 1886.

Early Finger Piece Eyeglass Mountings. (After E. C. Bull.)

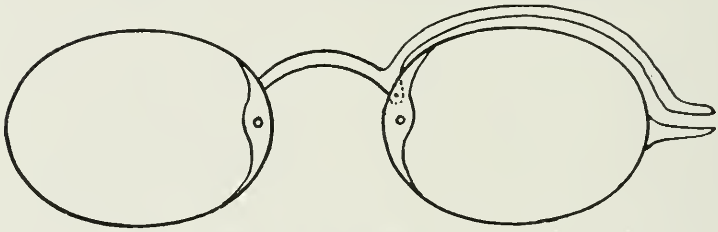
the brow. The former has become the bridge of the finger-piece eyeglass, manipulated with one hand, the guards being spread by means of levers, the lenses and bridge being stationary; the latter is perpetuated in the common eyeglass of today manipulated with two hands, the guards and lenses being spread by means of the elasticity of the

spring. These two developments may be followed further from the standpoint of springs and of guards.

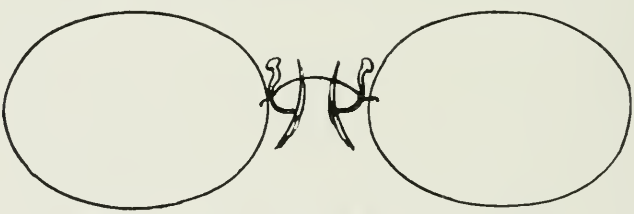
About 1870 a horizontally placed band-spring was made with two



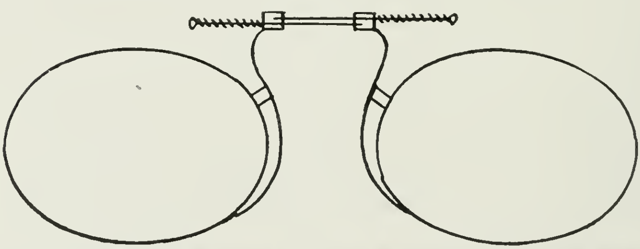
Model of Cyrus H. Farley of Portland, Maine, 1887.



Model of Walter C. Westaway of Decara, Iowa, 1890.



Model of Jules Cottet of Morez, France, 1893.



Model of I. H. E. De Celles and George W. Wells of Southbridge, Mass., 1893.

Early Finger Piece Eyeglass Mountings. (After E. C. Bull.)

finger pieces in front, pressure on which caused the lenses to be bent outwards and the guards to spread. Next a horizontal bar-spring was made to open by holding the handle and pressing on the bar, which

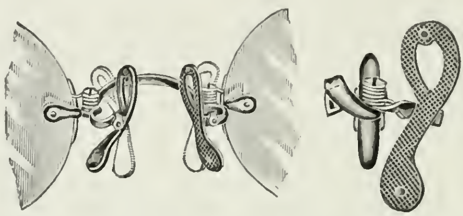
pushed the further lens away and opened the guards. Then, by means of a lever and fulcrum placed on the spring, an eyeglass was devised in which the lenses and guards moved up when pressure was made downwards with the fingers. A later model (1886) contained small arms beneath the lenses; by pressing these towards the lenses the guards were made to open. Again (1887) a bar-spring eyeglass was devised, pressure with the thumb on one bar and with the finger on the other causing lenses and guards to spread. More complicated was the arrangement (1890) of a chain or bar running around the upper edge of one lens to a finger piece above the handle; by pressing this together with the handle the further lens and guard were made to

Shur-on Eyeglass Mountings.

lift up. In these several models we observe that the lenses are pushed away, are bent out, are bent up, and are stationary; the last being the most satisfactory device.

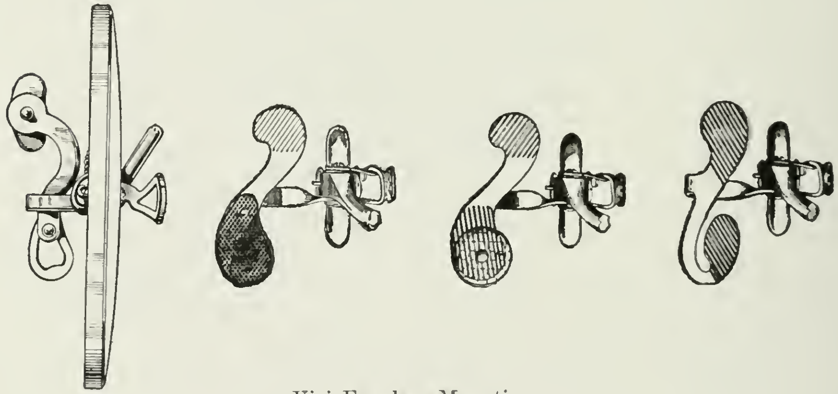
The year 1893 marks an important invention by a Frenchman, Jules Cottet. This was patented in France, Germany, England, and the United States, and was the forerunner of the successful finger piece eyeglasses. It consisted of "a C-shaped bridge flattened at the ends to take a screw supporting and carrying levers, the inner ends of which carried guards and the outer ends acted as finger pieces, the whole being controlled by a spiral spring" (E. C. Bull). Finch, of Colorado, devised an eyeglass similar to Cottet's, but having a saddle bridge and no screws to secure the arms. Meyrowitz manufactured this and made it the first popular finger piece eyeglass in America.

The finger piece eyeglasses are today the most frequently seen and popular form of glasses. They are neat and inconspicuous and easily manipulated with one hand. The rigid bridge joining the lenses gives a solid front like the spectacle bridge and lenses. Thus the adjustment is confined to the guards. The arm of each guard is pivoted to the bridge near the lens, with a projection forwards to make a finger piece



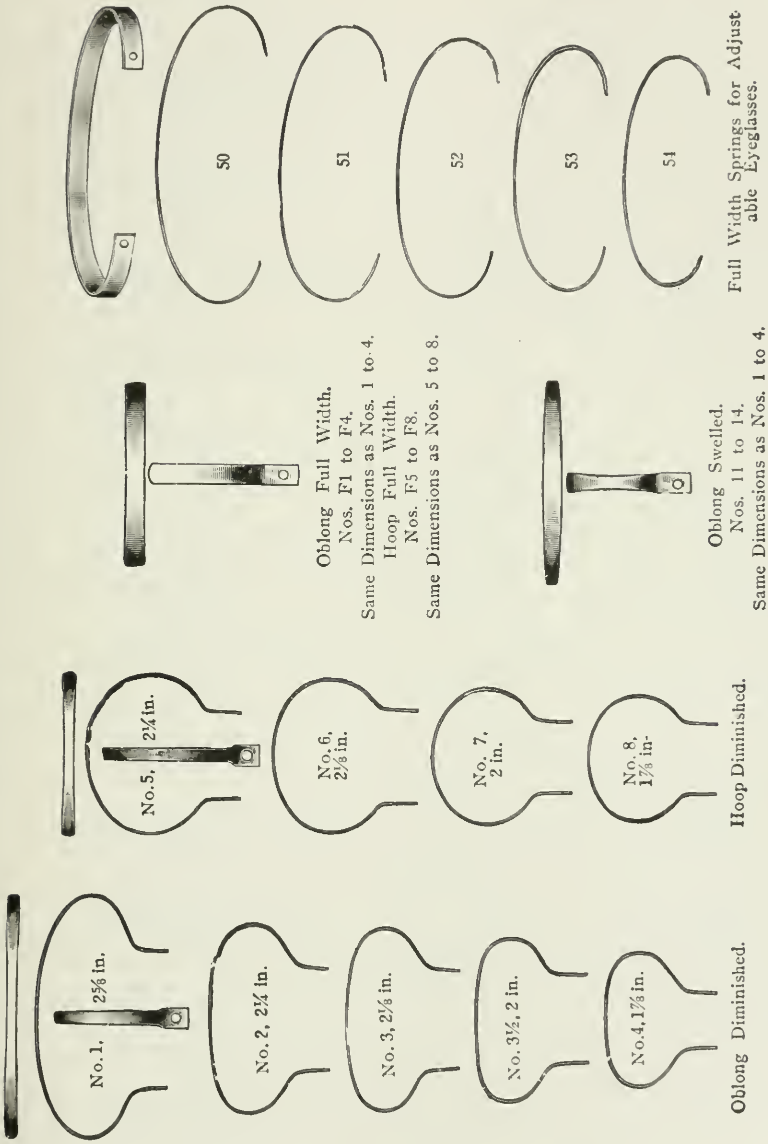
Fits-u Eyeglass Mountings.

and a projection backwards to make a guard which may have various shapes, as seen in the illustrations, and may be altered to conform to the surface of the nose on which it rests, to vary the position of the lenses up or down, and to vary the angle and the spread of the guards at top and bottom. Such guards are rigid or pivoted so as to rock; a



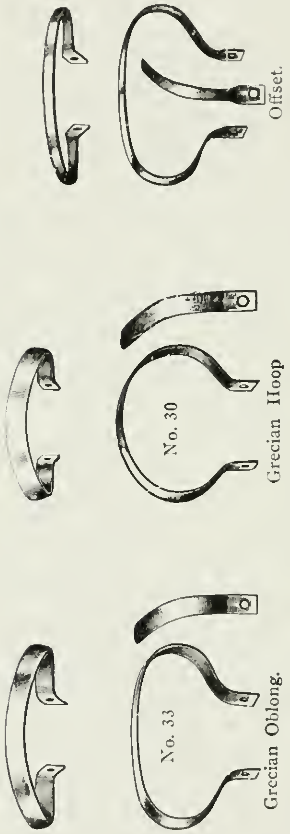
Vici Eyeglass Mountings.

combination of the two forms is utilized, being a rigid guard with an auxiliary small pivoted guard at the top. In general the guards have the shape of a figure 8, a bearing surface both above and below. They are "sanitary" (metal only) or covered with shell. They may or may not be perforated. The present tendency is towards the Wells or Fox type of guard. The additional pressure above secured by the Anatom-

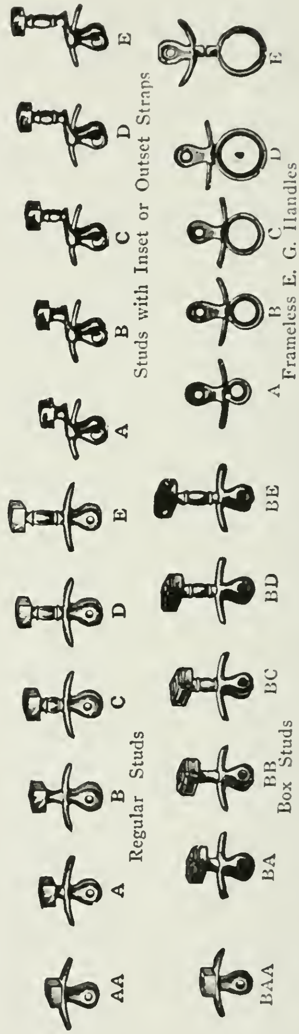


Modern Eyeglass Springs.

ical guards is also utilized in the finger piece glasses. All of these guards on the finger piece eyeglass are controlled by small spiral springs.

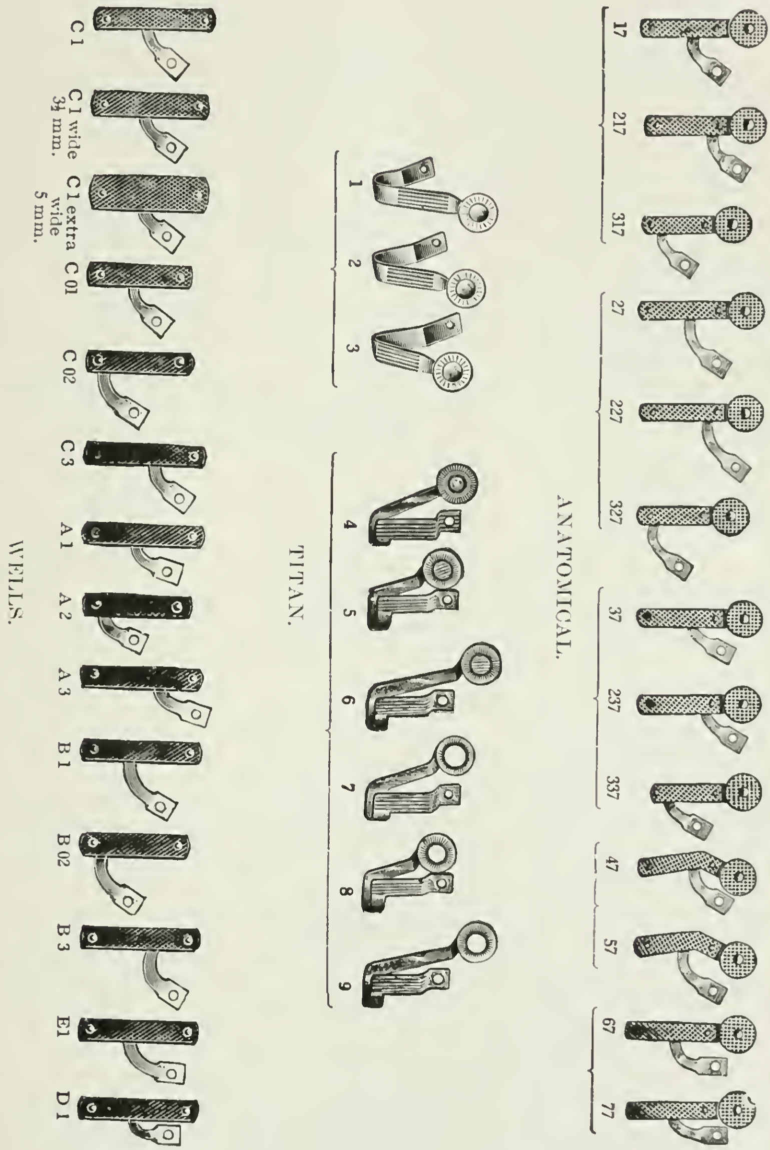


Modern Eyeglass Springs.

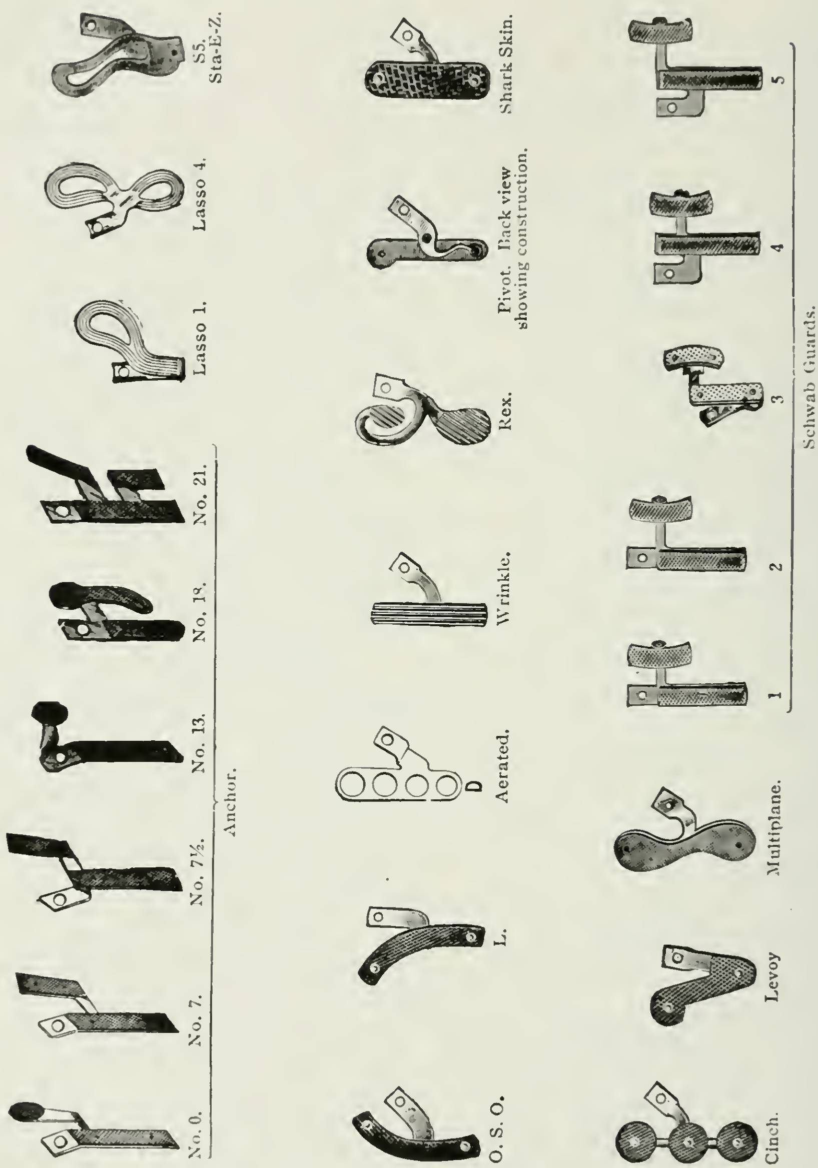


Modern Eyeglass Posts and Handles.

As has been observed, an eyeglass quite different from the finger piece type is in use at the present time. This form consists of a flexible spring rising above the level of the lenses, screwed to both studs and arms of guards. The studs, or posts, are attached to the lenses by screws (or soldered to eye-wires in the rimmed type). The guards



Modern Eyeglass Guards.



Modern Eyeglass Guards.

conform to the offset type of which there are numerous varieties. Springs are heavy or slender; in the plane of the lenses or offset (curving forwards to escape the brow); approach roundness in contour or are quite oblong. The posts vary in length; are in the plane of the lenses, or bend at a right angle to set lenses further forwards or backwards or downwards as the individual case may require. This type, until recently the common one, is rapidly coming to be regarded as the "old-fashioned" eyeglass.

From the ophthalmologist's standpoint, there is no "best" eyeglass. Each nose presents a separate problem, and from the great number of mountings on the market some one will generally be found smoothly and securely adjustable, unless the nose is of the infantile type or very deficient in bridge. When heavy or highly astigmatic lenses are required spectacles offer greater satisfaction through the support to the lenses given by the bows. In any case, accurate and permanent adjustment should not be sacrificed to the demands of fashion and fad.

Opifex Eyeglasses.

Three valuable improvements in bifocals have been made by the present generation of opticians. The cement bifocal was refined by the use of a very thin scale with a knife edge, made only circular in shape, to be cemented with balsam to the distance lens. This is known as the Opifex. The advantages claimed for it are accuracy in centering, cheapness and lack of chromatic aberration as compared with the Kryptok.

The Kryptok lens was made about the year 1890 by the optician Borsch, of Philadelphia. He first cemented together two large pieces of glass and a scale, the latter being between the surfaces of the large lenses. This was only a modified cement bifocal and had the drawback of all cements, namely the cracking of the balsam and separation of the lenses from slight jars to which all glasses are subject. Borsch later conceived the idea of fusing by great heat two pieces of glass, one crown and the other flint, the greater index of refraction of the flint glass making the difference between the far and near correction desired. The Kryptok is practically an invisible bifocal and hence

less conspicuous than the cement variety. It is difficult to grind and therefore expensive. Some individuals are distressed by a rainbow appearance at the junction of near and distance lenses when the presbyopic correction is stronger than 2.50 D.

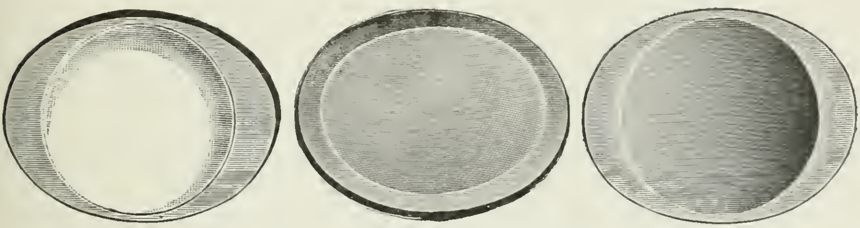
Recently the One Piece bifocal has been devised by the F. A. Hardy Company, of Chicago, for the purpose of doing away with chromatic aberration. Far and near lens are both ground from one piece of crown glass on the periscopic principle. The necessary curve to make the presbyopic difference is ground on the concave posterior surface, while the anterior surface comprises sphere, cylinder, prism, or combination of these as required.

''Invisible'' Bifocal.

In the year 1804 the periscopic lens was devised by the Englishman, Wollaston, for the purpose of obviating the disadvantage which comes from looking obliquely through the ordinary lens. It is well known that the full benefit of a lens is realized when looking through the center of the lens at right angles to its plane. This is possible in a given case only when the eye looks in one direction; every rotation from this position means some distortion of the object seen and some annoyance from reflections. By grinding a minus curve on the surface next the eye, and the necessary curve to give the required refraction on the other surface, a lens is placed closer to the eye, has more nearly the same refraction in all parts of the lens, offers a larger field, and is at right angles to the line of vision in all rotations of the eye as is impossible in the ordinary bi-convex or bi-concave lens. The ordinary curve in the periscopic lens is —1.25D; a deeper curve or meniscus is also used (—6.00D); these two being the standards recognized today. More difficult is the grinding of compound lenses in the periscopic style. Such lenses are called Toric, the anterior surface having the shape of a torus or ellipse, comprising two cylinders, while the minus curve is on the posterior surface. The very distinct advantages

of such lenses have been in part offset by their greater cost and the difficulty in grinding them without flaws.

Lenticular lenses are designed to reduce the weight of what would be, in ordinary form, very heavy lenses, as in high degrees of myopia and hyperopia (especially in aphakic eyes). Convex lenticular lenses are made by cementing the requisite scale on the center of a plano or plano-cylinder. Of more frequent use are the concave lenticular lenses, with either round or oval depressions in the center. The former is made by grinding the necessary concave surface upon one side of a plano or plano-cylinder. This depression occupies about 22 mm. in the center of the lens. The latter, or oval, type is made by grinding the necessary concavity upon the cylindrical side of a strong plano-convex cylinder or a cross cylinder. Such lenses are about one-half the weight of corresponding ordinary lenses and represent great skill in grinding.



Lenticular Lenses.

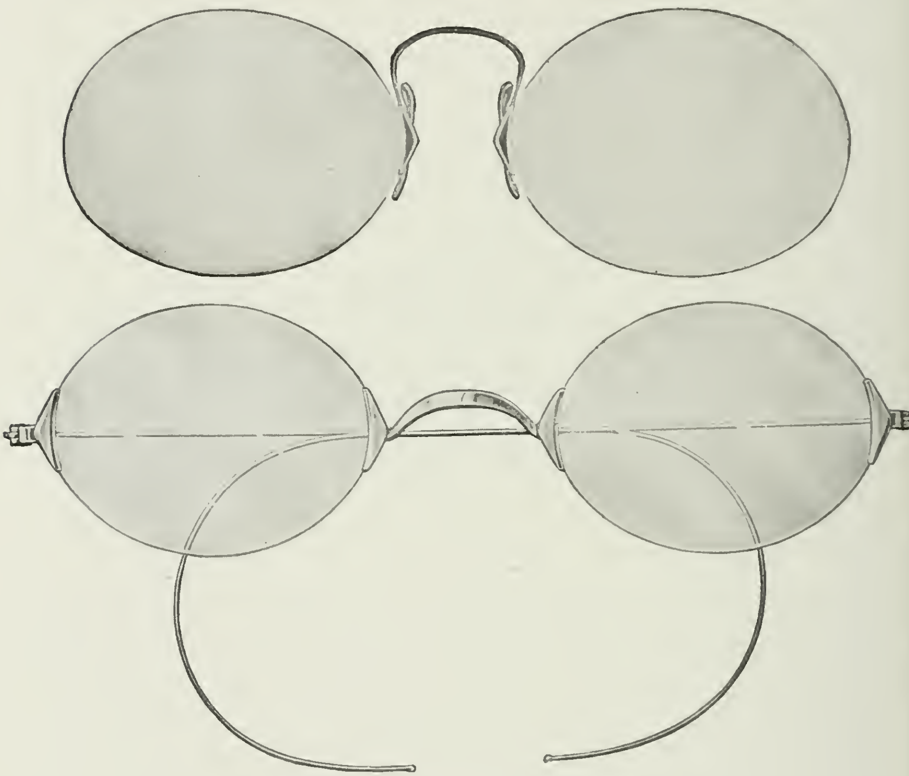
In 1879, at the Heidelberg Congress, Raehlmann proposed hyperbolic lenses for conical cornea and irregular astigmatism. His suggestion was a lens of 4 cm. diameter with the depth to the cone of ½ to 2 mm.

J. Herbert Claiborne, of New York, has quite recently (*Annals of Ophthalmology*, January, 1914) devised an improved cataract glass. This consists of a toric kryptok blank ground very thin, to the posterior surface of which is cemented a bi-convex lens. For example, to make a bifocal of + 12 with a + 2 segment, a toric kryptok with a + 2 segment is ground to a 1 mm. thickness or less, having a — 6 curve behind and a + 6 curve in front. On the posterior surface of this is cemented a bi-convex sphere with a + 6 curve on each side. This sphere is 25 mm. round, with a knife edge, its lower edge coinciding with the lower edge of the basal lens. Such a bifocal has about one-half the weight of the ordinary bifocal of equal strength.

In 1913 the so-called Coywell flint glass was suggested for the purpose of making high power lenses thinner and lighter in weight, as is

desirable in the cataract glass. It is estimated that a + 8 curve on this special flint glass is equivalent to an ordinary + 12 curve.

The history of colored lenses has already been discussed. Smoke, blue, amethyst and chlorophyll are the tints which have been regarded with favor. Several other varieties are to be mentioned: Arundel (1872), a pink glass; Uranium (1900), yellow; the Hallauer (1905), smoky green; Enixanthos (1906), smoky yellow; Euphos (1907),

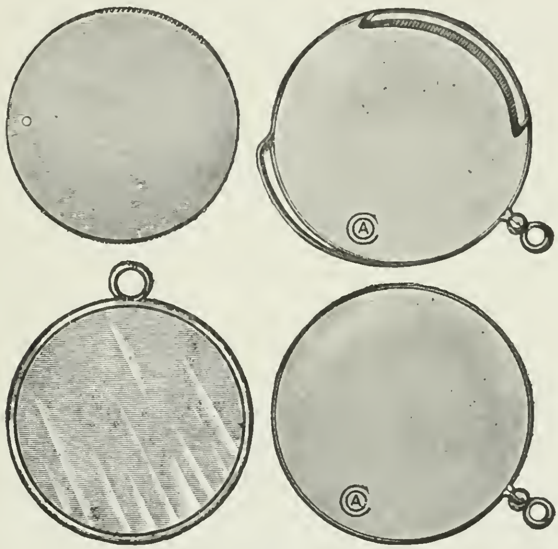


"Firmsett" Eyeglasses and Spectacles.

greenish yellow; Didymium (1909), salmon pink. Each of these is praised as possessing the property of absorbing certain harmful light rays, especially the ultra-violet. It is perhaps more correct to say that the virtue of all tinted glass consists merely in shutting out an excess of light. Recently several non-colored lenses have been introduced with the same claim of absorbing harmful rays. They are the Roentgen (1908), the Erbium and Yttrium (1910), and Radium glass (1911). See, also, **Colored glasses.**

A number of mounting and other devices have grown out of the effort to do away with the breaking of lenses where they are drilled to admit screws.

As usual with such inventions, many opticians experimented before the results became practical. Truske and Brayton, of Chicago, more than twenty years ago, devised the forerunner of the mounting now used which was patented by D. F. Green, of Fort Wayne, Indiana, in 1910. C. H. Pixley, of Chicago, also developed a practical cement for such a device as the "Firmsett." The George S. Johnston Company, of Chicago, now manufactures this mounting, which consists of a post



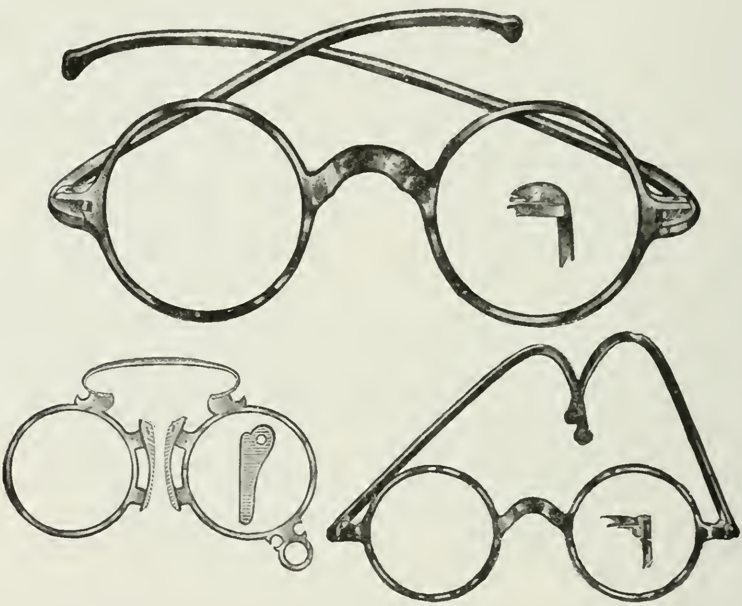
Monocles.

or "box" comprising two flanges, which embrace the lens where it is cut to an apex to insert deeply into this box. Lens and post are held together by a special cement. Such a device allows somewhat larger lenses to be used without altering the pupillary distance; it does away with holes drilled in the lenses; and the cement is said to hold permanently, regardless of temperature changes.

Several forms of glasses deserve mention as of minor utility. The monocle was evolved from the primitive reading glass held near the page. Later the glass was held before the eye with the hand; and finally the present-day lens, held in place by the tension of the brow muscles, came into being. When one considers the rarity of one defective eye with the fellow eye emmetropic and the greater ease and

security, even if such a condition exist, of eyeglasses or spectacles with a plano before one eye, it is easy to understand that the monocle is of extremely little use, and it is rightly regarded as an affectation. The device is almost a curiosity in America.

Of limited but real value is the lorgnette. Its prototypes were made with an unjointed handle at first, later with a jointed handle, and finally in the nineteenth century with a spring allowing the lenses to be folded together in compact form within the handle, which serves also as a case. Such a device, manipulated with one hand, can be



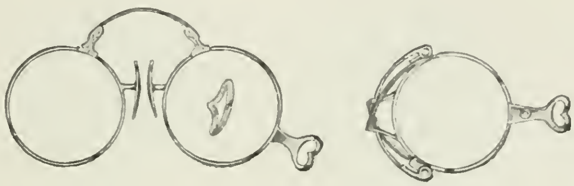
Library Spectacles and Eyeglasses, of Shell and Zylonite.

quickly placed before the eyes and is convenient for momentary use by presbyopes, who thus avoid being burdened with other glasses. It is to be observed that the word "Lorgnette" is a misnomer, meaning in French an opera glass; while the French word which should have been adopted is "Lorgnon."

As already stated, there is a tendency today towards the use of very large lenses mounted in bulky frames. These are denominated "Varsity" and "Library" glasses. Shell and imitation shell are used in both eyeglasses and spectacles, and also gold in eyeglasses. Lightness in weight of frames and large size of lenses are the virtues claimed

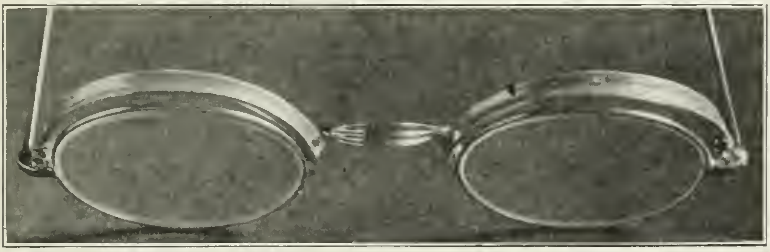
for these popular styles, while the important factor of accurate centering of lenses is too often ignored.

An extensive field for protective glasses is found in the various industries where men are subjected to injury from flying particles of stone, wood, or metal, and from molten metals. (See article on **Blindness, Prevention of,** Vol. II, pages 1161-1168, of this *Encyclopedia*).



"Varsity" Eyeglasses, of Gold, Silver, and Zylonite.

The function of protection against wind, dust and glare has assumed more importance with the growth of the automobile industry. Many styles of goggles are to be seen, all of the same general design, namely very large lenses and closely fitting. These may be flat and clear, but are more often toric and colored, and may have auxiliary protecting

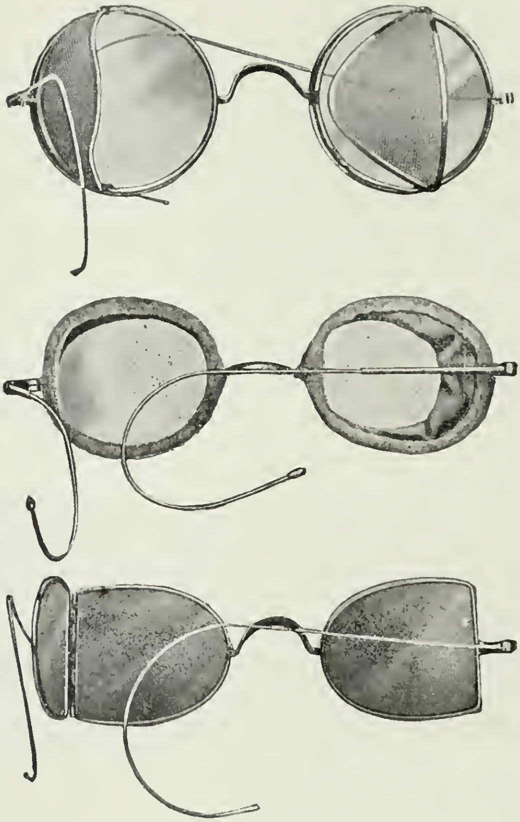


Spectacle Frame for Tennis Players and Farmers. (Gifford.)

lenses at the sides and various fabrics to cover the space between the margins of the lenses and the face.

A very recent device is offered to prevent annoyance from perspiration in the case of athletes and workers in hot weather. H. Gifford writes as follows (*Ophthalmic Record*, February, 1915): "Having been much annoyed while playing tennis or doing any hard work in hot weather by sweat running down from my eyebrows upon my glasses, I have had a pair of gutters made in aluminum which screw onto the sides of the bridge and the outside posts, which prevent this

trouble. The inner edge of the gutter fits close under the eyebrows and carries any excessive perspiration off to the sides. I think the frame may find a larger application among farmers than among tennis players, as any one who has attempted to pitch hay or do other hard work in the hot sun will readily appreciate. Many a farmer who ought to wear glasses either for visual purposes or to protect his only



Varieties of Automobile Goggles.

remaining eye will not do so on account of the dimming of the glasses in hot weather."

The very noteworthy progress in the optical industry in the past half century, especially in America, has kept pace admirably with the growing interest in refraction and scientific pursuit of this important phase of ophthalmologic work, which in turn has met the increasing need brought about by the peculiar conditions of modern life calling

for a maximum of close use of the eyes. Neatness, cheapness, and accuracy in adjustment of glasses, with many variations in style to satisfy individual taste, are obtainable today for the great number of people who need glasses.

The writer wishes to acknowledge his especial indebtedness to E. C. Bull, of Pasadena, California, formerly of Paris, France, for the use of his valuable material dealing with numerous phases of the subject, more particularly with the development of the American optical industry in the latter half of the last century, in which Mr. Bull himself has had a considerable share.—(E. H.)

Eyeglasses and spectacles, Mechanical adjustment of. Frame-fitting plays such an important part in the supplying of glasses that a thorough study of this work will prove of great value to the oculist. Many times a carefully prepared lens formula representing the nearest approach to an accurate correction of an error of refraction is entirely changed and the effect of the lenses neutralized by incorrectly fitted frames or mountings. Through force of necessity or choice a large number of oculists supply glasses directly to patients without the latter going to the optician; to these oculists it is especially important that they fully understand all the details of scientific frame-fitting. Moreover, even oculists who do not supply glasses should possess this knowledge, because it will not only increase the efficiency of their work but will often save many tedious, trying moments spent in determining the refraction of a patient, and in searching for a defect that is really caused by the mal-adjustment of the frame or mounting.

In these pages the subject will be discussed as fully as a work of this nature will permit, and modern methods of lens-centering and frame-fitting will be explained, as based on the experience of the writer and others.

Definitions. Frames: Fixtures that have rims going around the lenses. Mountings: Fixtures that hold rimless lenses. Spectacles: Fixtures that are held in position by means of bows (temples) that go around the side of the head and by a bridge that rests on the crown of the nose. When these have rims around the lenses they are known as spectacle frames and when there are no rims around the lenses they are known as spectacle mountings. Eyeglasses: Fixtures that are held in position on the nose by springs and by guards that press on the sides of the nose. With rims around the lenses they are eyeglass frames and without rims they are eyeglass mountings.

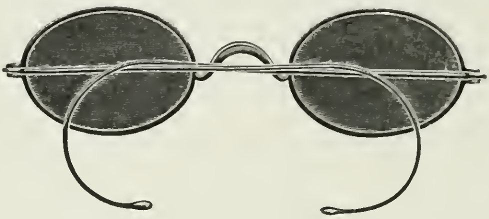
Spectacles. Temples: Attachments on spectacles that go around the side of the face and over the ears. Straight temples go straight back and do not circle the ears. Riding temples (sometimes called

riding bows) go entirely around the back of the ears. Half-riding temples are half way between the straight temple and riding temple varieties, just turning slightly over the back of the ears.

Regular temples: The ordinary wire temples.

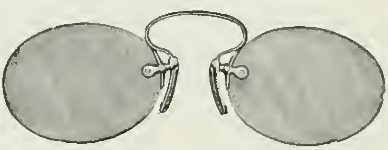
Cable temples: Made by wrapping two pieces of pliable wire about each other.

Half-cable temples: The part from the frame to the top of the ear is of the regular stiff wire, the part going around the ears is cable.

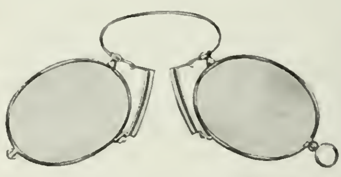


Spectacle Frame.

There are several varieties of this kind: Comfort temples, Apex temples, Velvet end temples, etc.; these are very similar in construction and differ only in the manner in which the soft portion that encircles the ear is attached to the wire that goes to the frame. They are all very soft and pliable on the ear end and are intended to increase the amount of comfort and eliminate the features of the regular wire temples that tend to make the latter uncomfortable about the ear.



Eyeglass Mounting.



Eyeglass Frame.

Bridge: The part of a spectacle that rests on the nose and connects the two lenses. This is the central and most important portion of a spectacle.

Shanks: The ends of the bridge that point outward from the nose and connect with the lenses.

Straps: The attachments at the end of the shanks and temples on rimless mountings by means of which the lenses are held to the mounting.

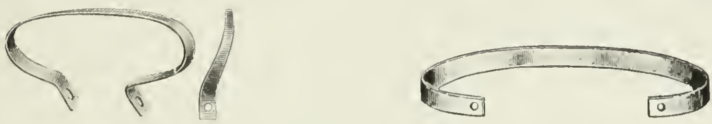
End-pieces: The parts to which the temples are attached in rimless mountings; they include the straps which are really a part of

them. When spoken of in connection with temples they are familiarly known as "ends," for instance, we speak of "temples and ends."

Eye-wires: The rims that encircle the lenses on frames.

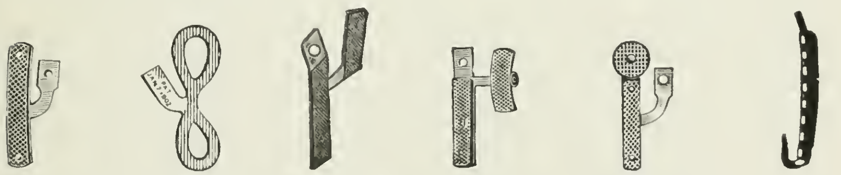
Eyeglasses (regular). Spring: The central part of the frame or mounting corresponding to the bridge of spectacles. There are sev-

Oblong. Hoop. Full. Reduced. Grecian.



Tilting. Adjustable.

eral styles of springs as shown by the illustrations. In addition to the different varieties there are different sizes; the usual length of the oblong style is $2\frac{1}{8}$ inches, and of the hoop style 2 inches. Oblong springs are sometimes called "square" springs and hoop springs are sometimes called "oval."



Wells. Lasso. Anchor. Schwab. Anatomical. Solid.

Guards: The parts that lie against the side of the nose and hold to the flesh; often called by the laity "clips." By consulting catalogs of the wholesale optical houses it will be seen that there are countless styles and designs. A few of the most common are shown.

Studs: The parts that hold the lenses to the mounting and which join the guards and the spring.

Open studs: Those in which the nasal side of the studs is left open.

Box studs: In these the portion into which the guard and spring fit is constructed like a box and the nasal side is closed, the stud-screw is countersunk, and thus there are no rough parts or exposed screws in contact with the patient.

In addition to these two styles there are many sizes, that is, some have longer posts than others, the purpose of which is to regulate the distance between the lenses. There are also "drop" studs to lower the lenses; these are made in two sizes—1-16 and 1-8 inch.

It will be observed that the sizes of studs (controlled by the length of the post) are indicated by the letters A, B, C, D, and E; A being the shortest and F the longest, with about one millimeter between each succeeding size.

Inset and outset studs: Most wholesale catalogs state that inset studs set the lenses farther from the eyes and that outset studs set the lenses

Showing Finger-piece.

closer to the eyes. To the mind of the average man who has not become accustomed to this translation of the terms they will seem to be reversed. Where this usage of the terms originated was with the idea that inset studs set the mounting in toward the face and consequently the lenses were set farther from the eyes; however, when we realize that the mounting always stays in the same position on the nose and it is the lenses themselves that are moved it would seem that studs that set the lenses out should be termed "outset," but the term is not generally accepted this way, so the safest plan in writing prescriptions, etc., that are sent away to be filled is always to say "to set the lenses closer to the eyes" or "farther away," as may be wanted, for instance: "Inset studs, to set the lenses farther from the eyes" or otherwise so as to be clearly understood.

Eyeglasses (finger-piece). Bridge: Same as the bridge in spectacles. This usually includes the studs, as they are generally made in one piece.

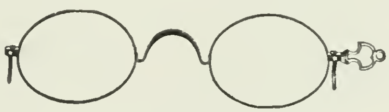
Finger-pieces: The projecting ends in front that are grasped by the tips of the fingers in order to operate the spreading of the guards.

Springs: These connect directly with the guards and cause them to press inward toward the nose.

Finger-piece eyeglasses are made in a great number of styles and combinations and are given particular names by the various manufacturers. While eyeglasses of this design appear at first sight to be very much alike, closer inspection will show that there are several classifications.

Miscellaneous frames and mountings. Grab fronts are fixtures to contain lenses, usually the addition for reading, which attach to the outside of spectacles, and may be taken off and put on without removing the spectacles proper. Grab fronts may be either with rims or rimless. Grab backs are similar to grab fronts except that they attach to the back of the spectacles instead of the front.

Specalettes are a combination of eyeglasses and spectacles, that is they are eyeglasses with temples. These are desirable where the patient has a straight and nearly vertical nose and experiences difficulty in retaining a spectacle bridge in the proper position, and in cases where



Grab Fronts

the skin on the front of the nose is very sensitive. There are several forms of these mountings and catalogs of wholesale optical houses may be consulted on the matter.

Lenses in common use. Double convex: Convex on both sides. Abbreviated, Dcx.

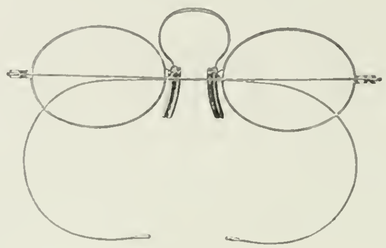
Double concave: Concave on both sides. Abbreviated Dcc. or Dccc.

Periscopic: This form may have either a convex or concave equivalent value for the lens, but to be periscopic a lens must have a convex curve on one side and a concave curve on the other. The ordinarily used periscopic lenses have a minus 1.25 diopter curve on the concave side of lenses having a convex power: this form of lens is generally accepted as better than the double variety. Abbreviated, Pcx. for convex and Pcc. for concave.

Toric: A lens having three curves. It has the appearance of a very deep periscopic, having one side deep convex and the other deep concave. By reason of its definition a toric lens can never be a sphere, but is always either a cylinder or sphero-cylinder. Torics are built on three base curves—the 3, 6 and 9 D.

Meniscus: A lens built on the deep periscopic form. This kind of lens is always a sphere and is often, though incorrectly, called a

"spherical toric." This latter term has come into such common use that it is generally accepted without question, in fact there are many who do not know that the term is technically wrong.

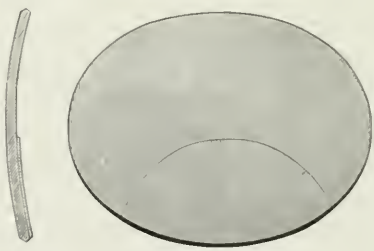


Specalettes.

Bifocals: Any lenses that are composed of two parts or have two foci. Usually these lenses combine the distant and near correction, the upper part for distance and the lower for reading.

Specalettes.

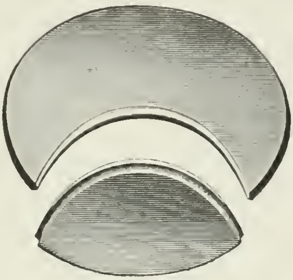
Cement bifocals: Any bifocal lenses in which the reading or near correction segments are attached to the main lens by cement, but usually understood to mean bifocals where the segments (or scales) are not especially thin and which are elliptical in shape.



Cement Bifocal.

Opifex bifocals: Lenses in which the reading segments are very thin, usually round, and attached to the main lens by cement. Sometimes called "semi-invisible" bifocals.

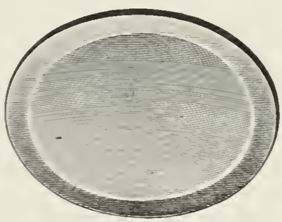
Kryptok bifocals: Lenses in which the reading segments are practically invisible and in which the segment is fused to the main lens forming one piece of glass. The segment and main lens are of different indices of refraction.



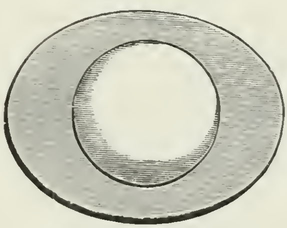
Perfection Bifocal.

Perfection bifocals: Lenses composed of two separate pieces of glass held in position by the rims of the frames.

Lenticulars: Lenses of a minus power in which the peripheral portions have been ground off flat or to a convex edge for the purpose of



Oval Lenticular.



Round Lenticular.

lightening the weight of the lenses and making them thinner on the edges.

Colored lenses: There are many different kinds and colors used, the prime purpose being to reduce the amount of light that enters the eye.

Smoked lenses are made in varying shades and densities. There are also green and blue lenses. Much has been claimed recently for amber lenses with the idea that they reduce the number of ultra-violet rays entering the eye. Likewise claims have been made for pink and amethyst shades. There are also lenses known by special trade names most of which are a combination of light-green and light-amber.

TABLE OF SIZES OF LENSES

Eye.	Inserts. mm	Rimless. mm	Short Oval Rimless.	Eye.	Inserts. mm
Jumbo	46 x38	46 x38	44.5x39.5	2	35x25.5
0000	44.3x36	44 x36	42.5x37.5	3	34x25
000	40.9x31.9	41 x32	39.5x33.5	4	33x24
00	39.7x30.7	40 x31	38.3x32.5	A	39x25
0	37.8x28.8	38.5x29.5	37 x31	B	40x26
1	36.5x27.5	37 x28	35.5x29.5	C	37x21

Shapes of lenses. In the majority of cases the regular shape lenses should be used, but the short oval is often very advantageous. Where the patient does a great amount of near work the short oval offers a large field of vision up and down, the direction in which it is most needed. This shape is also desirable in cases of narrow P. D., for here it is usually necessary to use small lenses which naturally restrict the field of vision.

The leaf shape is designed for people having heavy protruding brows; it resembles the short oval with the top rounded off. Odd shapes of lenses—that is, any but the regular and short oval—should be generally avoided, for their appearance is far from pleasing and gives suggestion of grotesqueness to the face.

For complete illustrations of the foregoing shapes, see **Eyeglasses and spectacles, History of.**

The correct frame or mounting. The unit of measure. The English system of lineal measures has so long been used that it is natural for this system to be employed by American opticians in giving dimensions of spectacles, etc., but since we have arrived at a place where accuracy and definiteness are essential, this system is no longer practical. The continual use of fractions permits the occurrence of too many errors and a specification of 1-8 or 1-16 inch gives room for too much variation one way or the other, whereas, if we measure by the

metric system when dealing with short distances we eliminate a large portion of the element of error both in calculations and in the matter of personal equation.

For instance, suppose we have $2\frac{1}{8}$ and $2\frac{1}{2}$ inches to compare. We have a general idea regarding the relation of these two quantities and after a little thought realize there is a difference of $\frac{3}{8}$ inch. Now express the same dimensions in millimeters—we have 53 and 62 millimeters. At a glance we have a definite appreciation of the relation and know instantly that there is a difference of 9 millimeters. Then again, on a scale graduated in millimeters the divisions are comparatively close together and a slight variance around the mark becomes evident at once.

Pupillary distance. There is just one simple method of ascertaining the exact distance between the eyes. Place yourself in a position directly facing the patient. Suppose you desire his P. D. for distance: Have the patient look over your head at an object on the wall opposite. Hold the rule in your right hand in the same manner as a pencil and steady your hand by placing your free fingers upon the side of the patient's head. Now, with your left eye (right eye closed) bring the zero of the rule opposite the line of demarcation between the iris and sclera, say, for instance in this case, on the nasal side of the eye. Holding the rule in this position quickly open your right eye and close your left and read off the graduation mark opposite the edge of iris (in this case temporal side) of the patient's left eye. This reading will give the true width between the eyes. Of course if you measure from the nasal side of one eye you measure to the temporal side of the other eye, and vice versa.

If you measure with both eyes open your result will vary 2 or 3 millimeters, because you will not be sure which mark is opposite the patient's eye. If you measure entirely with one eye the error of parallax will enter so much that your readings will always be from 2 to 5 millimeters too narrow.

To prove the veracity of the foregoing statements, make two marks about two inches apart on a piece of paper; lay the paper on your desk and resting your hand on it hold your rule one or two inches above it. First measure the distance with both eyes, then measure it entirely with one eye, and then with each eye separately (the zero with the left and the total width with the right eye) and you will find a decided variance in your three readings. By laying the rule flat on the paper and measuring the exact distance you will find your third measurement to be correct.

The spectacle bridge. There are two ways of expressing the dimensions of a bridge: By giving each dimension in figures or by using the size letter and number. The dimensions considered are height, inclination of crest, angle and width of base. The following letters are used to designate the width of bridges, beginning with the smallest: L, M, N, O, P. The heights are expressed in combination with the letters by numbers, as ½, 1, 1½, 2, etc. The shanks are called regular, long and extra long. With the regular shanks the lenses are held a trifle closer to the eyes than the crest of the bridge; with long shanks the lenses and crest of bridge are on the same plane; with extra long shanks the lenses are further from the eyes than the crest of the bridge is. Thus to set the lenses away from the eyes to escape the lashes, etc., we use long and extra long shanks. When no length shank is stated "regular" is understood. This is the way the different sizes of bridges are expressed: M, M½, N2 extra long shanks.

DIMENSIONS OF SADDLE BRIDGES.

(Upper figure Incnes, lower figure Millimeters).

Bridge.	Height.	Crest.	Base.
L	0 0	0 0	5/8 15
L½	1/16 1½	0 0	5/8 15
L1	1/8 3	0 0	5/8 15
M	0 0	1/16 1½	5/8 15
M½	1/16 1½	1/16 1½	5/8 15
M1	1/8 3	1/16 1½	5/8 15
M1½	3/16 4½	1/16 1½	5/8 15
M2	1/4 6	1/16 1½	11/16 17
N	0 0	1/16 1½	3/4 18
N½	1/16 1½	1/16 1½	3/4 18
N1	1/8 3	1/16 1½	3/4 18
N1½	3/16 4½	1/16 1½	3/4 18
N2	1/4 6	1/16 1½	3/4 18
N2½	5/16 7½	1/8 3	13/16 20
N3	3/8 9	1/16 1½	13/16 20
O	0 0	0 0	7/8 21
O1	1/8 3	1/16 1½	7/8 21
O2	1/4 6	1/16 1½	7/8 21
O3	3/8 9	1/16 1½	15/16 23
P1	1/8 3	1/16 1½	1 25
P2	1/4 6	1/16 1½	1 25
P3	3/8 9	1/8 3	1 25

When the sizes are not specified as above it is necessary to give all the dimensions in figures. The height of the bridge is the distance above or below a line running through the center of the lenses to the lower edge of the center of the bridge; the inclination of the crest is the distance from the inside plane of the lenses to the upper edge of the middle of the bridge and is specified "in" or "out," meaning in back or in front of the lenses, respectively. The angle of the bridge is considered with respect to the plane of the lenses, the latter being 90 degrees. The angle is measured at the center or crest of the bridge.

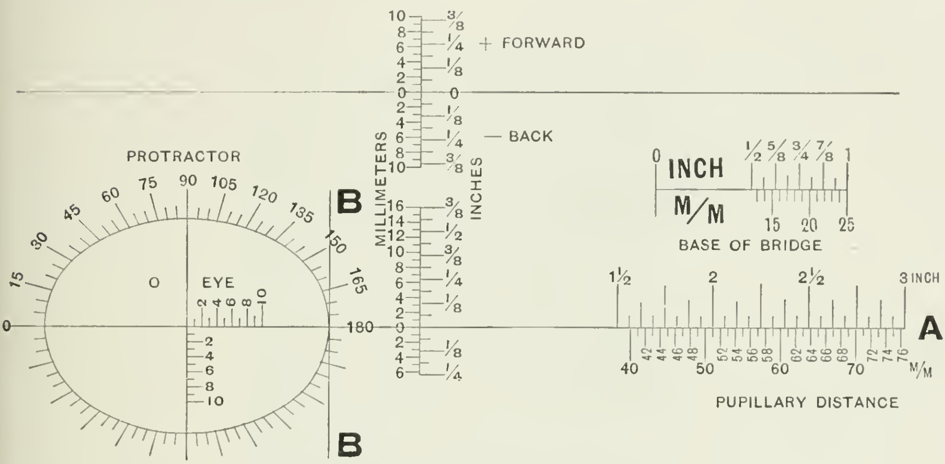
Temples. The length of the temples is measured from tip to tip, that is from the screw hole to the extreme other end. The average length is six inches, but they are also made in lengths of 5½, 6½ and 7 inches.

Sizes of lenses. "Size eye," as it is familiarly called, represents the outside measurement. The regular sizes are jumbo, 0000, 000, 00, 0,

1, 2, and 3, beginning at the largest and going to the smallest. The "size eye" of frames agrees with the size of the lenses.

"Pupillary distance" is a term so often used that we have come to know it familiarly by its abbreviation, P. D., so that in this article we shall refer to this dimension as P. D. instead of writing the words in full.

The accompanying illustration shows a measuring card used for measuring spectacle frames.



Card for Measuring Spectacle Frames

To measure P. D. and height of bridge, place end pieces on line A-A with inner edge of left eye at line B. The figure at right end of right lens indicates the pupillary distance and that at under edge of bridge crest indicates the height of bridge.

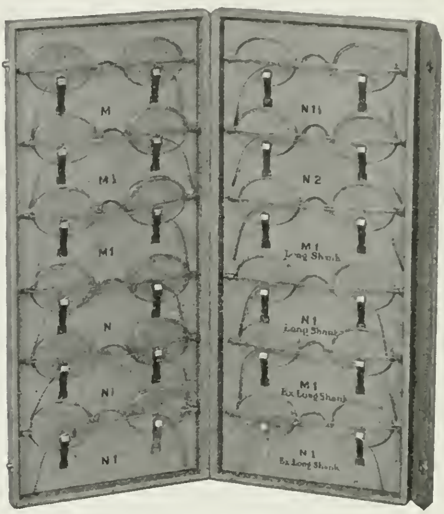
To measure bridge crest, forward or back, place lenses in slots, top down, with inner surface of lenses on lower edge of slots. That edge of bridge resting on card will indicate position of crest.

It will be noticed that in measuring the "pupillary width" of spectacles and eyeglasses, a similar plan is followed as when measuring over the eyes; that is, the distance is taken from the nasal edge of one lens or rim to the temporal edge of the other lens or rim. This is most conveniently accomplished by using the measuring card designed for this purpose shown here.

Measuring for spectacles. Before going further, one should know exactly all the details already given, otherwise he will get most unsatisfactory results. For instance, one may take the base of the bridge to be from center of the turns of the shanks and the optician who fills the

order will take it from the last points where the flesh touches the bridge, with the consequence that the spectacles received will always be from two to three millimeters too narrow. The same applies to all the other dimensions, but this is cited as being the most common error. For illustration:

One may be provided with a 6 or 6½-inch rule graduated in both inches and millimeters; a measuring card, and a fitting set of spectacle frames. Then, seated directly in front of the patient, measure the patient's P. D. and note it down. Select from the fitting set the



Spectacle Fitting Set.

bridge that comes nearest to fitting the patient's nose. Notice the use of the word "nearest" in the previous sentence—it is only once in a hundred times at least that one will find a stock size that will exactly fit.

Height of bridge. Now for the proper bridge dimensions: With the frame, just selected, on the patient's face, note whether the lenses set too low or too high, bearing in mind the use that the patient is going to make of his new glasses, whether for reading, distance or both. The average line of vision should be through the center of the lenses. Suppose the lenses in the fitting frame set too low, say one millimeter. Now, if we move the bridge down the lenses will go up a corresponding amount, so, in this case, the bridge we want should be one millimeter lower than the one on the fitting frame. Take the frame from the patient's face and measure the height of this bridge;

suppose we find it to be four millimeters. We found this was one millimeter too high, so the bridge we want should be three millimeters in height. Mark it down on the prescription pad.

Position of the crest. Replace the frame on the patient's face. Note whether the lenses set too close or too near the eyes. Suppose the lenses touch the lashes and need to be set two millimeters farther out for the lashes to clear. Take the frame off and measure the position of the crest of the bridge, using the measuring card for this purpose. Suppose we find it to be three millimeters out, then as with this bridge the lenses are two millimeters too close to the eyes, the bridge we want should be two millimeters farther back, which gives us one millimeter out (or forward) that the bridge crest should be. Note this down under position (or inclination) of crest.

Width of base. Place the fitting frame on the patient's face, using a bridge of sufficient width to allow the crest to strike the nose; push the frame to the right or left, so that all the space between the bridge and nose will be on one side. By ascertaining how much this space is we know how much too wide the bridge is, and by measuring the bridge and making the deduction for oversize, we have the proper width.

Remember, that the base width is measured from the point on each side where the flesh last touches, and not from the middle of the turns of the shanks. The width of base is one of the most important dimensions of the bridge and decides to a large degree whether the spectacles are comfortable or not. The bridge should fit the nose just like a saddle, for if it touches all around it will help support the weight and relieve some of the strain at the back of the ears. At the same time a bridge too narrow at the base will press into the nose and be very uncomfortable.

Angle of the crest. The average angle subtended by the bridge of the nose is 45 degrees, the plane of the face being 90; in other words, the more vertical the nose the higher will be the number which represents its angle. To measure this angle hold a rule or card perpendicular to the plane of the face and note the size of the angle between the rule and the nose where the spectacle bridge will rest.

There are cards made to take this measurement, as well as other little contrivances.

Length of temples. There are two ways of expressing the length of temples desired, i. e., the distance to back of the ear, or the entire length of the temple from tip to tip. The first measurement is made with the fitting spectacles on the patient's face, the two extreme points being the plane of the lenses and the middle of the back of the ear.

The other method is to notice how the length of the temples on the fitting frame suits, measuring the full length of these temples and then adding to or subtracting from this length as may be necessary.

The instructions given here apply to both rimless and frames. Some use four or five spectacles of different sizes to measure over, but the use of a complete set of 12 sizes is advised.

Eyeglasses. The finger-piece type has come into use within the last ten years and on account of neatness of appearance, the property of retaining its original shape and adjustment, and simplicity in fitting, it has become very popular and widely used. However, there are cases where the regular style is more desirable than the finger-piece, and vice versa. For instance, a finger-piece mounting has a tendency to cause the nose to appear shorter and the face narrower, while the regular mounting gives rise to reverse impressions. This being the case, a finger-piece mounting on a short nose makes it seem shorter; a regular mounting would lengthen it. If one fits a finger-piece mounting where the pupillary distance is comparatively narrow, the eyes will seem still closer together, whereas a regular mounting will seem to put more space between the eyes.

Regular.

"Regular" style. To ascertain the correct size of lens, length of stud, style of guard, etc., it will be quite necessary to have an eyeglass mounting to measure over.

First measure the patient's P. D. Then adjust a sample mounting as well as possible and place it in the correct position on the patient's nose. Now measure the P. D. of the glasses while on the face (measure from inside edge of one lens to outside of the other); this places one in position to know how large to make the lenses and how long the studs. Suppose, for illustration, that the sample mounting is equipped with regular B studs and 0 eye lenses, that your patient's P. D. is 60, and that the P. D. of the glasses, when on, is 58 millimeters. One sees at a glance that these glasses would be too narrow and their P. D. must be increased 2 millimeters. There are two ways in which this can be accomplished: by using longer studs or larger lenses. The next size studs to those on the sample mounting are known

as C studs, there being a difference of one millimeter in the length of a B and a C. By using C studs in the case we are considering we will increase the P. D. of the glasses 2 mm. (1 mm. on each stud), and thus obtain the desired width of 60 mm. By increasing the size of lenses 2 mm. and leaving the studs as they are in the sample (B size) we can obtain the same result. The lenses in our sample are 0 eye size and their length therefore is 39 mm.; adding 2 mm. to this gives 41, which is the length of 000 eye lenses, hence by using 000 lenses and B studs we obtain the desired P. D. With these two methods we can make several combinations and get exactly the dimensions we want. For instance, we have studs ranging from A to F (about 1 mm. difference for each size) and lenses ranging from 1 eye to jumbo, or in figures, from 37 to 46 mm. long, which we can combine in a great many different ways.

Notice when the mounting is in the proper position on the nose whether the lenses are too close to or too far away from the eyes. If they are too close use inset studs to put them farther out, if too far away use outset studs to bring them closer. Both of these styles are made in two sizes, 1-16 and 1/8-inch, and one can easily tell which size is required.

If the brows are prominent and press against the spring use a Grecian or a tilting spring. Oblong springs are usually used for men and hoop springs for women, but this is a matter of personal choice.

The guards selected should have a flat surface where they come into contact with the flesh—this is the first requisite of an efficient guard. In adjusting the guards it must be borne in mind that contact and adhesion count greater for desirable results than pressure, and for this reason the guard must be curved and bent to conform with the corresponding part of the nose.

One should have about six eyeglass mountings, complete with lenses, and having different styles of guards and springs. With this equipment one may select the style of guard that will be best for each particular case.

Some styles and angles of guards will set the lenses lower than others, but usually it is necessary to drill the holes in the lenses 1-16 or 1/8-inch above center to lower them, especially where the glasses are to be bifocal or reading lenses, in regular eyeglass mountings.

Finger-piece eyeglasses. Having decided what mounting fits the best, note the number it bears that represents its size. Measure the P. D. of the patient and then measure the P. D. of the glasses. If these two measurements are alike prescribe the same size lenses as those in the fitting mounting, which is usually 0 eye size. If the

fitting glasses are too narrow in P. D. increase the size of the lenses until the proper P. D. is obtained, provided of course that it is not more than a few millimeters and does not make the lenses too large. The 00 eye lenses are one millimeter longer than 0 eye size and will increase the P. D. just one millimeter; 000 eye lenses are two millimeters longer than 0 eye and will increase the P. D. the same amount. One does not have to be controlled, however, by the standard sizes; 000 eye lenses have a length of 41 mm., we can use 42, 43 or 44 mm. lenses if desired. There is usually about 9 mm. difference between the length and breadth of regularly shaped lenses, so we can specify 42x33 or 43x34, etc., instead of trying to convert these lenses to a standard size. Likewise where it is desired to give a short oval effect one may specify 42x34 or 42x35, etc., but always remember that when measuring the P. D. of a pair of glasses to measure from the inside edge of one lens to the outside edge of the other lens and in this way the length of only one lens is included in the total P. D. and consequently an increase in the length of both lenses of 2 mm. will increase the P. D. of the glasses only 2 mm. and not 4 mm. as might at first be supposed.

Let us say that, in order to cause the glasses to have the proper P. D. it would be necessary to use larger lenses than are desired. In this case one must use extended posts; these correspond to the C and D studs in regular eyeglass mountings and are made in just two sizes, $\frac{1}{16}$ and $\frac{1}{8}$ inch. Should we put on $\frac{1}{16}$ extended posts we will increase the P. D. $\frac{1}{8}$ inch, or about 3 mm., and $\frac{1}{8}$ inch extended posts would increase the P. D. $\frac{1}{4}$ inch, or about 6 mm. Here it will be seen that both posts must be considered in the P. D., as we include them both in the P. D. measurement.

Now observe whether the lenses are too close or too far from the eyes; if so prescribe inset or outset posts, whichever are needed, the same as when fitting regular mountings. Outset and inset posts are made in two sizes, $\frac{1}{16}$ and $\frac{1}{8}$ inch, and it will be found comparatively easy to judge which size is needed.

Summing up, the things we need to know in prescribing finger-piece eyeglass mountings are: The number or size of the mounting, extended, inset or outset posts and the size of the lenses.

ADJUSTING SPECTACLES.

Before considering the adjustment of spectacles let us analyze the conditions that must be presented by a properly-fitting spectacle frame or mounting. The lenses must center before the eyes and sit just

as close as possible to the eyes without touching the lashes. In glasses that are to be used for general work, i. e., both distant and near, the line of vision should be just a trifle above the center of the lenses when the eyes are directed straight ahead. Every part of the frame must give entire comfort; the bridge must fit all around the curve of the nose like a saddle on a horse's back, and the temples must be just the right length.

There are pliers that are specially designed to do particular kinds of work, and it will be advantageous to be supplied with the proper tools and to know their respective uses, for one cannot accomplish satisfactory results when not properly equipped in this regard. The following styles of pliers are necessary in adjusting spectacles: Snipe-nose (half round), full round, concavo-convex, bridge angling, and stud pliers. There are other styles that will facilitate the work, but these just enumerated are absolutely needed.

If the lenses are too high and it is desired to lower them, bend the shanks of the bridge downward, but remember that this will lower the angle of the bridge and allowance must be made accordingly. If the lenses are too low, bend the shanks upward, remembering that this will also alter the angle of the bridge.

The angle of the bridge may be varied by angling the crest with ordinary snipe-nose pliers or by curving the shanks upward or downward at the eyewire or strap, but the best way is to use pliers that are especially made for angling, for instance, the Berg pliers, by means of which the angle can be changed properly in a very short time.

The shanks may be lengthened or shortened to control the distance of the lenses from the eyes by changing the relative position of the point at which the bridge curves to make the shanks. First, with a pair of snipe-nose pliers flatten out the curve in the shank, then with a pair of full round pliers put the bend in the bridge just where you want the shanks to begin and continue to bend the shanks over until they are brought into the proper position. It is quite essential that pliers with full round jaws be employed for making these curves, as the other pliers will mark and cut the covering of the bridge.

The pupillary width of the glasses should be controlled by the direction taken by the shanks without disturbing the width of the base of the bridge.

The width of the base should be altered by using pliers that have one jaw concave and the other convex. Changing the base will also affect the pupillary width. In bending a bridge it will be wisest to ascertain just exactly what alterations are necessary before making

any, due to the fact that every dimension is dependent upon the other and a change in one will cause a corresponding change in some of the others.

To bend temples so as to angle the lenses, or where one ear is higher than the other and one temple must be raised, use two pairs of pliers; with stud-pliers grasp the end-piece close to the edge of the lens or eyewire and with a pair of snipe-nose pliers take hold of the outside end of the end-piece and bend the part of the end-piece to which the temple is attached, so as to move the temple upward or downward as may be desired; in other words, the end-piece is slightly twisted. Above all things do not curve or bend the temple itself, but confine the bending to the end-piece.

To curve the temples for the turn of the ear use a pencil or something else round and curl the temple as one would a feather, by drawing the end of the temples between the thumb and the pencil. Temples may be curved outward in a similar manner where they cut into the flesh on the side of the face.

If one lens sits higher than the other it may be that one ear is higher than the other and the trouble should be rectified by angling the temples.

Adjusting eyeglass mountings. We shall consider here two kinds of eyeglass mountings in general, that is, those of the finger-piece type and those with the regular hoop springs. In differentiating between these two kinds the spring of the regular and the bridge of the finger-piece mounting are the essential points and the same rules will apply to both classes of mountings except where they apply to these two conflicting portions.

The first aim in fitting the eyeglass is to make it stay on securely with comfort, and in effecting this we cannot sacrifice correctness of position, so that many times we are confronted with a complex problem when endeavoring to make these three features work harmoniously.

The guards themselves must present a smooth surface to the flesh and must be curved so as to conform to the contour of the portion of the nose over which they rest. To curve the guards in this manner it is quite essential to have the proper kind of pliers; the best for this purpose are those that have one convex blade and one concave, so that by simply pressing the blades together that portion of the guard assumes a corresponding curvature in degree depending on the amount of pressure given the pliers. By using pliers of this kind the guards may be accurately curved without interfering in any way with the remainder of the guard or its general angle, etc. Suppose now after the guards have been given the proper curvature, and

granting the other parts of the mounting are evenly balanced and straight, that one lens is higher than the other. We will say, for instance, that the left lens is higher than the right. Take the curved pliers and bend the bottom of the left guard out slightly, being careful not to bend it so far that it leaves the flesh. If this is not sufficient to lower the lens, bend the entire guard on its axis, so that the bottom portion does not press so hard; this will bring the top of the guard tighter, but care must be exercised not to bring this in too tight. Further lowering of the left may be accomplished by raising the right lens, which is done by bending the right guard in toward the nose slightly at the bottom. It is surprising how bending of the guards will affect the respective heights of the lenses.

In all cases the top of the guard should be curved out slightly to agree with the curvature of the nose as it merges into the brows; if this curving is not done here the top of the guard will cut into the flesh and prove very uncomfortable. It is the bottom of the guard that supports the weight of the glasses and the top that prevents them from tilting over, so that the top of the guard must necessarily press a trifle harder than the bottom, and as a general thing more pressure can be stood here than at the bottom, because there is nearly always a little cushion of flesh here. Wherever the guard rests on a bony part of the nose the contact must be very even and the pressure comparatively light, else the guard will cut the skin. By giving the guards the same curve as the nose they will stick to the skin and much less pressure will be required than otherwise. Another good plan is to bend the entire guard out from the back, so that there is more pressure along the front or outside edge of the guard than at the back; this will cause the flesh to pile up slightly, as it were, in front of the guard and form a wedge of the flesh which prevents the mounting from slipping forward.

In the case of a regular mounting with the hoop spring sometimes it is desirable to have the spring tilting slightly at the top away from the forehead on account of heavy brows or high nose. There are springs that are made with this tilt, but if the mounting one is adjusting is not tilting and it would be preferable to have it so one can very easily bend it to have the desired tilt. To do this use what is known as stud pliers, taking them in one hand and gripping the strap of one of the studs with them. Grip the pliers tightly and with the thumb of the other hand press against the top of the spring and one will find that it can be bent outward. After doing this take hold of the other stud with the pliers in a similar way as before and repeat the operation on this side, thus evening up the tilt from both sides.

When placing eyeglasses on a patient's nose do not hold the glasses by placing the fingers on the two sides of the lenses, but allow the fingers to touch only the edges of the lenses.

If the guards are covered with shell, be sure to smooth off the edges all around, using a fine, flat file for the purpose. It will often be found in cases where the mounting is not comfortable and the guards are covered with shell or a similar substance that the trouble can be relieved by filing the edges of the shell on the guards.

When mountings contain toric lenses the efficiency of the lenses may be increased by bending the lenses in toward the temples. This enables the patient to look sideways without being annoyed by the edges of the lenses.

[*Adjusting bifocals.* Mr. E. E. Maddox, speaking of the troubles that most people—especially active-minded neurasthenics—experience in their attempts to get accustomed to bifocals, says: "So great is the convenience of bifocals that they should, if possible, come into universal use whenever both the far and near corrections are necessary. Yet it is a matter of common observation that while some patients take at once to their bifocals, with evident satisfaction, others experience a rather stormy introduction to their use, and many are obliged to abandon the attempt to wear them owing to the 'irritating effect,' as they call it, of the upper margin of the reading segment.

"The following little expedient, I find, contributes towards the education of those who cannot at once become reconciled to the presence of the dividing line. It consists in painting a black line at least one millimetre broad on the posterior surface of the glasses, along the upper edge of the reading segment. Indian ink, mixed with gum or 'seccotine,' which can be easily washed off when required. affords a very suitable pigment. The mind being kept conscious of the presence of this band, finds less difficulty in learning to look either above or below it, and, when the lesson is well learned, the band can be washed off.

"The irritating effect of the dividing line is due partly to the double vision from the prismatic action of the edge of the reading segment, and partly also to scattered light, to which some eyes are so much more sensitive than others, and which acts much as a nebula upon the cornea would do. A black band is far more soothing, and if painted truly, is not nearly so unsightly as might be anticipated. It has indeed rather a purposeful look.

"As distinct from this educational band, I think it would be well to make a practice of staining the margin of the reading segment with a dead black in all cases, and even in the uni-bifocals, the lower edge

of the larger segment should be thus stained, so as to lessen adventitious reflections into the eye. Since the stained margin looks upward or downward, it would not be sufficiently visible from the front to counterbalance its advantage to at least those who have some retinal hyperesthesia.''—Ed.]

One of the chief objections to finger-piece mountings is that they are apt to sit too high and to sit farther from the face at the bottom of the lenses than at the top. Great care must be exercised to prevent these two conditions, and it will be well to understand how to overcome these difficulties. The standing away from the face at the bottom of the lenses can be rectified by spreading the guards at the bottom and by making them incline somewhat from the vertical. The custom of bending the ends of the bridge downward and drilling the holes above center is not advised in cases where it is desired to set the lenses lower, because it spoils the appearance of the mounting, narrows the base of the bridge and disrupts the proper working of the springs and finger-pieces. The better plan would be to fit mountings in which the guard-arms are so constructed that the guards may be raised without changing their angle, or mountings that are supplied with drop-studs, or ''tangent'' studs, as they are called by some. To increase the tension of springs on finger-piece mountings detach the long end of the spring, gripping it with a pair of pliers, and pull the spring tighter on the coil. To decrease the tension push back on the coil. In cases of springs of the lever variety in which it is not possible to adjust the tension of the coil, bend the long free end; to increase the tension bend it toward the side it presses; to decrease, press toward the opposite side.

HOW TO ORDER OPTICAL WORK.

This is one of the most important subjects and should receive very careful attention. As far as possible in describing the style of frames or mountings catalog numbers should be used.

Fundamental rules. Use a separate blank for each order or each pair of glasses. Write clearly and avoid vague descriptions.

When ordering lenses be sure to state the size of the eye, and whether rimless or for frames.

Give each prescription a number or patient's name and the date.

Sign your name at the bottom.

Do not write instructions across printed matter, as this makes them very difficult to read.

Name or number. It is well to give each order a name or number,

which will be useful when writing about an order or for other future references.

Formulas of lenses. When the usual form is followed of writing the sphere first, the cylindrical value next, and the axis of cylinder next, it is not necessary to append the abbreviations "Sph.," "Cyl.," or "axis," even when not written on a tabulated blank, in which case the form should be thus: — 1.50 — .75 x 90.

When distance lenses only, or reading lenses only, are wanted give the formula for the particular correction you want, and not both. When both formulas are given, as in cases where bifocals are desired, it is best to give the total reading correction in full and not the addition for the bifocal portion. In such cases where the addition is given you should be very particular to append the word "Add" after the amount to be added. It is because it is so easy to forget to affix this little word that it is much better to always give the full reading correction after the addition has been made.

Other lens specifications. Always state whether you want "toric" or "flat" lenses. While, strictly speaking, there is no such thing as a "spherical toric," the correct term being "meniscus," the term "toric" is generally accepted as applying to all lenses constructed on a deep periscopic base. By "flat" lenses is meant all lenses that are not toric (or meniscus).

Give the "size of eye" in the proper space; this is the size of lens as has been previously described.

When lenses only are being ordered and one does not want them put into a frame or mounting, be sure to state whether they are to be rimless or inserts (for rims), and if rimless how many holes to be drilled in them. In specifying for the drilling of holes always specify the number of holes per pair, even in cases where only one lens is ordered.

Should one order just a single lens, and not send the other lens to be matched for thickness, be sure to give the thickness of the lens at the "strap," or, in other words, where it is attached to the mounting. This thickness may be ascertained by measuring with a millimeter rule or by using a strap gauge.

If one does not give any instructions regarding how the holes shall be drilled they will be drilled "on line;" in cases where one wants the lenses to set lower when using eyeglass mountings, specify that the holes should be drilled above center, stating how much, thus: Drill one-eighth above, or drill one-sixteenth above, as the case may require.

The frame or mounting. Know just what is wanted here and give

specific instructions, for this part of the order is just as important as that which refers to the lenses; remember the man who fills your order does not see the patient and must have definite dimensions by which to be guided if he is to make up a frame or mounting that will fit.

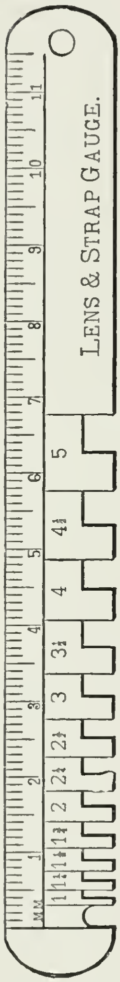
Eyeglasses. In the proper space state what style of mounting is desired and what kind of material wanted, such as gold filled, solid gold, nickel, etc. As far as possible it is well to give catalog or stock numbers, because these are quickly read and understood, save space on the order blank and save time in the shop. When ordering finger-piece mountings remember that the numbers given in the fitting set refer to size of the bridge only and not to the particular style of mounting. For instance, let us say one is fitting from a set of mountings known as the "Staythere Mountings," and decides that a No. 842 is the size desired and the patient orders gold filled, on the order specify "G. F. Staythere 842." Thus one covers every point of style wanted, so that the man who fills the order knows positively just what is wanted. It will take but a moment to decide what size lenses are needed and to mark it down on the order. Remember that 000 eye size is just one millimeter longer than 00 eye, and that 00 eye is just one millimeter longer than 0 eye, and each change of eye size will make just one millimeter difference in the pupillary width of the glasses. In ordering eyeglasses of the finger-piece type the only data necessary are:

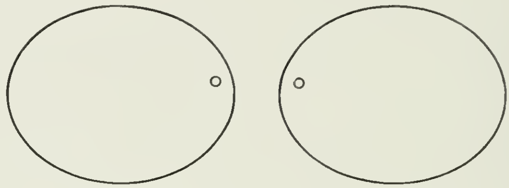
Material, style, size of mounting and size of lenses. Pupillary width and "spread of guards" are superfluous when ordering any kind of eyeglass mountings or frames, because the pupillary width will be controlled by the size of lens and size of mounting, and the "spread of guards" will have to be effected when one fits the mounting to the patient's face, for eyeglass guards cannot be adjusted "by mail."

Most of the foregoing applies to finger-piece mountings; hoop spring mountings must be ordered in a somewhat different manner. Give the kind of material, size of lenses, size and style of studs, style of guards, size and style of spring.

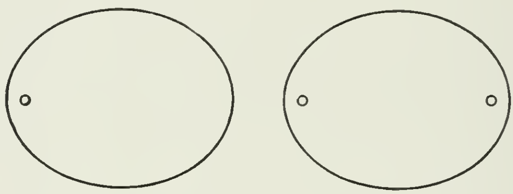
Spectacles. State the style of frame or mounting and what kind of material wanted, the size of eye, pupillary width; give the bridge dimensions regarding height and position of crest, either in figures or by a bridge number; state the angle of crest and width of base. The length of temple may be expressed either by giving the total length from tip to tip, or by giving the distance in a straight line from the plane of the lens to the middle of the back of the ear; the former is preferable, because it is definite. The style of temple should be stated at the same time of specifying the style of the mounting.

There are stock sizes of bridges that have stated dimensions and these various sizes are designated by letters, such as M, N, O, etc. Where the dimensions of the bridge wanted are not given in figures the letter representing the size desired may be given in the space on the blank usually headed "bridge number;" it is much more desir-

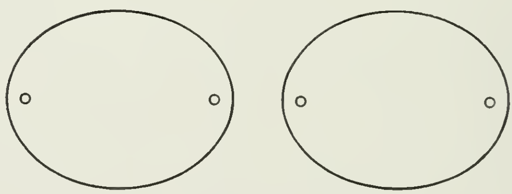




2 Holes Per Pair "1/16 above line."



3 Holes Per Pair "on line."

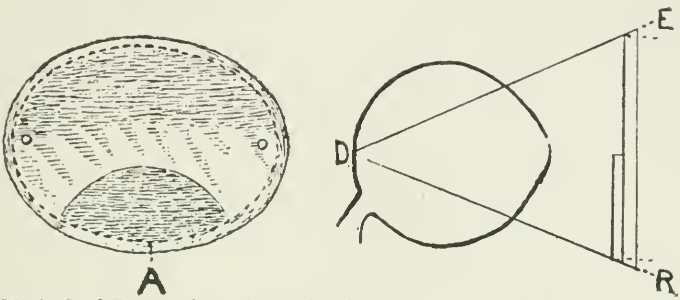


4 Holes Per Pair "on line."

able to give the dimensions in figures, however, as this insures a well-fitting bridge. Where the letter is used to denote the size of bridge wanted it is not necessary to enter the figures for height, position of crest or base, as these dimensions are covered by the letter given as the bridge number.

See illustration of strap gauge for ascertaining thickness of lenses, and how drilling of lenses is specified.—(R. D. P.)

Rhoades (*Prac. Med. Ser.*, p. 16, 1911) has put into practice a plan to remove color aberrations and reflections from the edges of frameless eye-lenses and cemented bifocal segments, and at the same time get rid of the harassing band of white light which comes from the same source, by beveling the edges of the lenses, as shown in the figures of this text. The relief is especially marked when the patient has a tired retina.



Method of Preventing Aberration in Frameless Glasses. (Rhoades.)

The edges of all frameless lenses should be ground to a bevel of about 45°, as shown in the cut, and they will look to one in front of the glass, as in the second figure, indicated by the broken line. In high hyperopes the angle would be sharper. In low myopes the angle would be lower. Then, too, the angle would alter a little with the shape of the lens. If, to be sure, the lens was circular the angle would be the same all around, but being oblong the angle should vary accordingly. In short, the angle of the edge of the lens should be from 40° to 45° and should be governed by the size of the lens and the degree of asthenopia. The length of the lashes and the contour of the face would also enter into the perfect elimination of this vicious subtile halo, and the final result will be good or bad in proportion to the skill of the optician.

The prismatic hues which are sometimes so bitterly complained of by people wearing cemented bifocals can be entirely overcome by grinding the segment to the retinal angle, i. e., all its edges should be ground so as to point to a focus on the retina. On top the edge should be square and should be gradually beveled at both ends until the bottom is reached. The bottom edge should be ground to the same angle as the distant lens. The fused bifocal cannot be entirely rendered achromatic; however, the bottom edge can be.

Recently, Rhoades has been impressed with the fact that the bright-yellow gold straps are a rich source of chromatism, and are as harmful

to the eye as is the color from the edges of the lenses. He blackened these straps with india ink and was amazed at the result. Not only was the color trouble from this source corrected, but the band of bright-white light was changed into a dull neutral gray. Let it be understood, that Rhoades is speaking of the vicious band of light from the unbeveled edges of the lenses, and that the blending to a dull gray was due to blackening the straps and not blackening the edges of the glasses. He did blacken the edges afterwards with the result that the live, white reflecting lens was changed into a dead neutral one.

The writer quoted is fully alive to the fact that this pathologic ray is not going to be disturbed in its citadel. He says this for two reasons. First: The oculist and the optician are not going to urge the use of such glasses, and what is worse will condemn them without trial. They will rarely, if ever, order glasses with blackened inner straps and beveled edges, fearing their patients will upbraid them for prescribing such an unfashionable device. Second: The average patient will not wear them if prescribed. They would, however, wear any fashionable glass, even if told that it might immediately do them some slight harm, and would take all kinds of liberty if told they would have to pay a severe penalty only in the dim future. There are some who have already begun to pay this penalty, and others with slow tired retinas, who are willing to do anything to get relief. At least, let relief be given to those who are willing to accept it. Chauffeurs, motormen, engineers, and all those who must face the vicious horizontal rays, will be relieved and safeguarded by using this kind of glass.

There can be no doubt but that in neurasthenic patients, in many myopes and in most patients with diseased fundi the foregoing remarks are well worthy of consideration.

To diminish the annoyance of *bifocal glasses*, Maddox (*Ophthalmoscope*, Vol. IX, p. 413, 1911) advises painting a black line at least 1 mm. broad on the posterior surface of the glasses along the upper edge of the reading segment. India-ink mixed with gum is a suitable pigment. This expedient is intended principally toward the education of such as do not readily become accustomed to bifocals. The mind being kept conscious of the presence of this band, finds less difficulty in learning to look either above or below it, and when the lesson is well learned the band can be washed off. As distinct from this educational band, he thinks it would be well to make a practice of staining the margin of the reading segment with a dead-black in all cases; even in the unibifocals the lower edge of the larger segment should be thus stained so as to lessen adventitious reflections into the eye. The stained margin would not be sufficiently visible from the front to

counterbalance its advantage in cases of retinal hyperesthesia. He truly observes that it is the neurasthenics who find the greatest difficulty with bifocals.

Baker (*Ophthalmoscope*, Vol. IX, p. 499, 1911) has placed the reading segment upon the upper part of the distance glasses and mounted the combined lenses on a trunion so that they can be reversed when the segment is required for near work. Such an arrangement can obviously only be used in the case of spheres and where the axes in astigmatism are just horizontal and vertical, and even here the centration would be apt to be disturbed from the frequent changes which would have to be made in passing from distant to near vision. Toric lenses could not be handled in this way.

Finger-piece mountings for eyeglasses. Although we are not in the habit of noticing articles in trade journals yet the following (*Hardy Messenger*, Aug., 1910) is so instructive to the oculist that we copy it without further comment.

Within the last few years there has been placed upon the market a new style of eyeglass mounting, the principles of which are radically different from those formerly in vogue. This new style almost immediately received public favor and has grown more and more popular as its utility and beauty have become known.

This mounting is fast superseding all other styles of lens mountings. It is known as a finger-piece eyeglass and is so called because it may be removed or adjusted without touching the lenses. These mountings have many excellent features; they also have some bad ones. Among their good features may be noted a rigid bridge, or one that holds the lenses in perfect horizontal and vertical alignment, or in the same position as would a riding bow spectacle with a saddle bridge. With such an eyeglass the axis of cylindrical lenses will be held correctly, or as nearly so as they would be if mounted in a spectacle.

The guards of these mountings are of various shapes. They are made to grip the nose by small springs which force them together or against the nose. The arms of the guards are pivoted to the bridge near the lenses; they project both forward and rearward. The forward ends are bent outward over the lens clamps and form finger pieces which may be gripped by the thumb and forefinger when the glasses are to be removed or adjusted. The guards are attached to the rearward extension of the arms. Some of them are attached rigidly and others loosely, or in such a manner as to allow them to rock. The former are known as "rigid," and the latter as "rocking" guards. Those styles having rigid guards are susceptible of much greater ad-

justment than are those with rocking guards, yet both styles have both good and bad features.

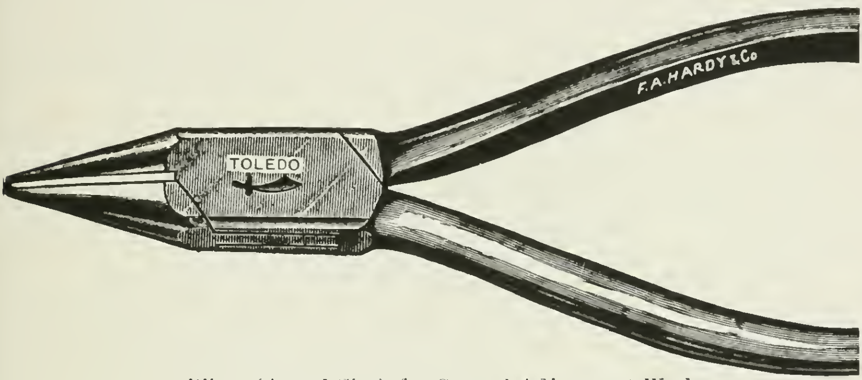
The rearward ends of the guard arms may be bent up for the purpose of lowering the lenses or down if it is desired to raise the lenses or to set them higher. This makes the adjustment for height very easy and allows the lenses to be drilled at the center. The angle of the guards may be changed at will, also the spread at the top or bottom or at both top and bottom. The flare may also be quickly changed to any angle desired, so that the guards will lie flat upon a nose of any shape. As a rule the guards are made entirely of metal and are easily given any curve desired, either at their tops or bottoms, or both ends may be curved as desired. The bridges have different lengths and different heights, also different inclinations.

The dimensions of the bridges are practically the same as are those on riding bow spectacles. When one of these mountings is correctly adjusted the bridge will rest upon and have the same contour as the nose, thus doing away with the unsightly spring of the old style eyeglass. It was almost impossible to place the old style upon the nose twice alike, for if the guards did not rest upon the identical spot each time the lenses would not occupy the same position. They might have a greater or less pupillary distance, or they might not lie in the same horizontal or vertical plane or have the same inclination or height twice in succession.

One great fault with the old style was the drooping of the lenses. This drooping was a vital error if the lenses contained a cylindrical element, for the axis of the cylinder was surely removed from its true position if the lenses drooped.

Practically all of the faulty features of the old style eyeglass have been eliminated in the new style. The bridge being rigid, the distance between the centers of the lenses is always maintained and they are always held in the same vertical and horizontal plane. The inclination may not always be exactly the same (this is not vital, however), but it is more nearly maintained in the new than it is in the old style. This is due to the fact that when the new style is being adjusted the bridge is made to rest upon the nose, and when the fingers are removed from the clips the guards fall upon the same parts of the nose every time. The optician, when fitting the old style, had to choose his guards from a score or more of different styles and his spring from dozens of different shapes and sizes, and his studs from many different lengths and styles, and then to assemble them and afterward to adjust them to the patient's nose. This selection of the most suitable material and the final adjustment requires not alone experience, but both experience

and skill. For this reason many oculists have practically refused to prescribe eyeglasses in many cases. They could not be confident that certain lenses would prove satisfactory if mounted in an eyeglass. This fear of eyeglasses is wearing away and they are now prescribing the new style with confidence. The springs on these mountings have given the manufacturers more or less trouble, but evolution has been and is still going on and in time this new mounting will be worn almost universally except by the aged and infirm and by children. The beauty of the new style is universally admitted and there is no question, especially among the ladies, that the wearer of a modern rimless eyeglass looks many years younger than she would if she wore spectacles.



Pliers (Actual Size) for General Adjustment Work.

These mountings are adapted for all styles of lenses, particularly for the "peritoric" styles, and for bifocals. Any interpupillary distance may be obtained by prescribing a lens whose length, plus the length of the bridge, equals the interpupillary distance. Short ovals and torics are popular shapes.

Tools used in ordinary adjustments and mounting of lenses. In the bending and adjusting of spectacles and eyeglasses the surgeon who elects to do this work should have sufficient tools for the purpose. Even then he should not attempt those tasks that are the part of, and can only be properly done by, a workman whose shop is equipped with appropriate machinery.

The *plier* is a necessary instrument for almost every adjustment. The one mostly used has a long narrow snipe nose, both for bending the bridges of spectacles and for adjusting eye-glass mountings, because so much of this work is the "lining up" of glasses, and also grasping one part of a mounting while bending another. For this work we need a flat jaw plier the nose of which is so narrow that we may be

able to insert it into small curls, and to have sufficient purchase while bending, that the plier will *not* slip, thus preventing accident or marring the mounting.

The round or B nose plier is used for rolling the bridges in order to set lenses farther forward or closer to the eyes. To set lenses farther forward we grasp a bridge at the curl with one hand, and by holding the bridge securely with the other hand roll the bridge around the plier, thereby lengthening the shank. To set lenses nearer the eyes we reverse the operation.

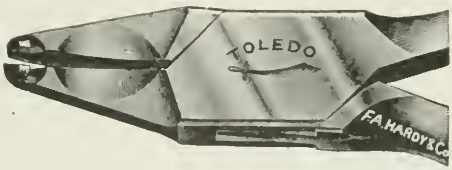
The concave-convex plier is used either to make a bridge narrower at the base or to bend eye-glass guards to conform to the contour of the nose. The narrow jaw or G plier is best suited for eye-glasses, and the wider or E nose plier for spectacles. These pliers should never be used for making the base wider, as they make a very uneven bend and mar the metal too much. The pliers can also be used to bend the temples so as to conform to the back of the ear.

The plier, known as the J, is used for tilting end pieces when it is desired to make lenses pantoscopic for near work or when one ear is higher than the other. In rare cases we find both ears are so high that it is necessary to bend the end pieces in order to set the lenses retroscopic. To tilt lenses for near work, grasp the end piece to be tilted with the flat side next the rim and with a snipe-nose plier held on the outer end of the end piece twist it to set the temple higher or lower as the case may require; care must be taken to only twist the end piece and not bend it up or down.

The many cases of irritated and cut nose from an ill-fitting spectacle bridge crest can be remedied with this plier. It has always been necessary to send this work to the optical shop, but with this plier it is very simple. If the lower edge of the crest cuts the nose, the crest must be made more horizontal. By placing the bridge in the plier with the lower edge of the crest toward the ends of the plier we can change the angle to 15° more horizontal, and by setting the bridge in the plier the reverse way we can make the crest 15° more vertical. It is only necessary to line the glasses up again after making this adjustment, as the use of the crest plier does not change any other measurements.

The Peterson shanking plier is used principally to change the height of a spectacle bridge for the purpose of raising or lowering the lenses. To lower the bridge we grasp the shank of the bridge from the front just inside the lens strap, allowing the lenses to rest in the grooved part of the plier for the purpose. Hold the plier very securely in one hand, and with a snipe-nose plier in the other hand bend the shank

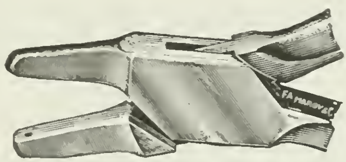
down at the curl: release the Peterson plier and while still holding the shank push the crest of the bridge down to the desired height, thereby raising the lenses and finishing the operation. When it is necessary



The Peterson Shanking Plier.
Used principally to alter the height of the spectacle bridge.

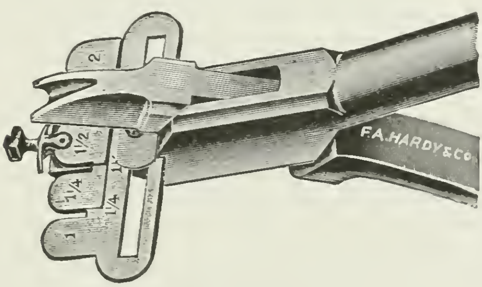
to lower the lenses, bend the shank and crest up instead of down, using the Peterson plier as before.

In adjusting eye-glass mountings we use a snipe-nose plier for regular



The Vici Plier.
Used for tilting and "truing up" eye-glasses.

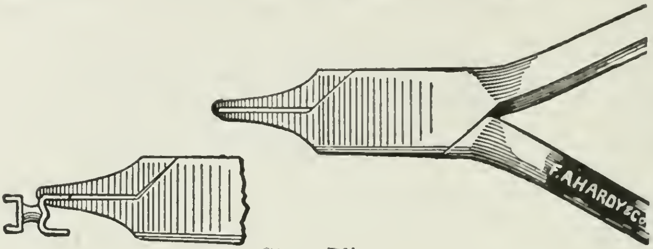
bending and "truing up," and the round-nose plier for rolling the arms of guards forward or back, in order to set lenses at the proper distance in front of the eyes.



The Hardy Strap Plier.

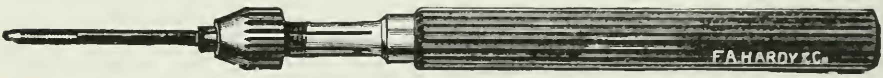
The Vici plier is made especially for tilting the outer ends of lenses up or down in "truing up" eye-glasses. The holes which are drilled in the inside of the jaws are to engage the spring screw at the top and bottom. They hold the screw securely and prevent any danger of

bending the screw or springing the threads, which is sure to occur if any other plier is used for this work. This plier can be used equally well on all styles of finger-piece eye-glass mountings.



Strap Pliers.

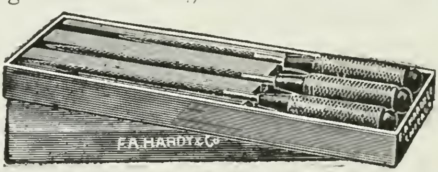
Many times it is necessary for the oculist to order lenses from the optician, and then to insert them into the mountings himself. In order to do this work satisfactorily he must be equipped with a few special



Skeleton Screw Tap Mounted in Handle.

forms of pliers. The first plier to be considered is one used for shaping the strap to fit the new lenses.

If the mountings are too wide, first determine the thickness of the



Rat-tail Files.
Used for enlarging screw holes of lenses.

lens at its edge by inserting the end of the lens into the slots in the sliding bar of the plier, then insert the corresponding lug of the plier into the strap of the mounting, and by one squeeze of the plier the strap is changed to the exact width of the new lenses.

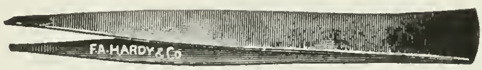
In case the mountings are too narrow for the new lenses, insert the short jaw of this plier into the strap, as illustrated, and roll the shoulder of the strap to the desired thickness. Care should be taken in shaping straps, to have the inside face of the strap fit perfectly flat on the lens. This is a very important point, as lenses very easily crack if the straps are not parallel with the lenses.

If necessary the holes may be enlarged a little with a rat-tail file

in order to have the strap not too tight and to avoid chipping the lens at the screw hole.

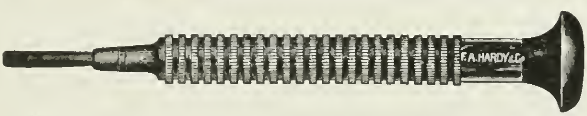
After the straps are properly shaped the skeleton screw tap is used to cut a new thread which will allow the screw to fit easily and prevent turning off the head or breaking a lens by forcing the screw through the old thread. New screws should be used in place of the old ones, to insure perfect results.

The Chappel Cutting Plier.



Tweezers.
A useful instrument for picking screws from bottles, etc.

The Chappel cutting plier is the best cutting plier because it obviates the necessity of filing the ends of screws after cutting. The cutting



Metal Screw Driver, with Revolving Rubber Head.

knives are sharpened to so fine an edge they must be used only for cutting gold, gold filled or soft metal screws, and with this precaution will give good service for a long time. When they become dull or worn they may be sharpened by the optical jobber.

A pair of long narrow-nose tweezers will be found very useful in picking screws from bottles, etc.

A strong metal screw driver with revolving rubber head and sharp thin point is recommended.

The rimless lens screws may be purchased from the optical jobber in bottles containing 1,000 each.—(B. A. Weeks.)

Eyeglasses, Fitting of. See **Eyeglasses and spectacles, Mechanical adjustment of.**

This expression is also used in the sense of determining or "working out" the refraction of a patient.

Eye-glass frames. See **Eyeglasses and spectacles, Mechanical adjustment of.**

Eye-ground. Fundus oculi (q. v.).

Eye jar. A container, usually made entirely of glass, to hold the preserved eyeball (or a portion of it) as a museum or laboratory specimen. See **Museum preparations.**

Eyelashes. CILIA. These are well-developed hairs of various colors, arranged in two and sometimes three rows at the palpebro-conjunctival junction. The cilia of the upper lid are longer and more numerous than in the lower. In the former situation they number from 90 to 150, while in the lower lid from 40 to 80 are generally seen. The hairs curve in opposite directions in the lids, so as to present their convex curves to one another. The eyelashes are of different ages and exhibit different stages of growth. They are constantly falling out in a perfectly normal fashion—the life period of each cilium being about four months.

They are entirely of ectodermal origin and develop in the same way as hairs over other portions of the skin.

As part of an *external examination of the eye*, the eyelashes should be carefully inspected as to their number and direction. Search should be made for small white downy hairs, especially near the inner canthus, where they are apt to rub on the globe or caruncle. Short, thick, black hairs, the so-called "wild-hairs," often produce much irritation. Parasites may be found about the roots of the lashes. See **Examination of the eye**; also **Cilia**; as well as under **Comparative ophthalmology**, Vol. IV, p. 2625, of this *Encyclopedia*.

Eyelashes, Bleaching of the. POLIOSIS OF THE CILIA. This condition, in a subject otherwise normal, and free from any discoverable hereditary taint, is of very infrequent occurrence. A case was reported by Usher (*Trans. Ophth. Soc. Unit. King.*, 1906, p. 23) of a three-year-old girl, normal in every other way, in whom all the eyelashes on the left side, on both lids, were quite white, and there were two tufts of white hair on the left side of the head. On the right side all the eyelashes were light-brown. There was more hair on the body than is usual, especially at the spine and neck, which was nearly white, and downy. See page 2224, Vol. III, of this *Encyclopedia*.

Eyelash, Implantation of an. This injury, consisting of the "planting" of a cilium in some of the tissues or cavities—anterior chamber

especially—will also be described under **Injuries of the eye.** A typical case is that described by Hirschberg (*Ophthalmic Record*, July, 1909), in which the porcelain stopper of an exploding beer bottle struck the left eye of a man, aged 31. There was a small penetrating wound at the lower, nasal quadrant of the corneo-scleral junction, coagulated blood in the anterior chamber, and the pupil was covered with exudates. The eyeball was very soft and painful. The continuous pain and irritation of the other eye suggested the presence of a foreign body in the globe. Eleven days after the injury Hirschberg detected with the loupe, on oblique illumination, a very fine eyelash implanted in the iris at the medial pupillary margin at the nasal upper portion of the cornea. The iris, at this place, showed a slight circumscribed swelling, with new-formed, fine blood vessels.

In deep narcosis, the medial limbus of the cornea was incised with a lance-shaped knife, and the eyelash grasped with a forceps. The hair, however, was not extracted with the forceps, but lay in the wound from which it was removed. The diseased portion of the iris was excised. The pain ceased at once, and after two weeks the eye was without irritation. Hirschberg mentions another case of purulent iritis caused by a penetrating eyelash, which he published in 1892. In both cases the speedy removal of the cilium saved the eyes and prevented sympathetic ophthalmia.

Eye-lens. In *optics*, the lens placed immediately in front of the eye and through which the virtual image produced within the tube by the *object-glass* or *objective* of an astronomical telescope is seen under a greater angle than that subtended by the object viewed by the naked eye. The eye-lens may be either convergent or divergent. If the former is used, the distance between the objective and the eye-lens is slightly less than, or at most numerically equal to, the sum of their focal lengths, the image being magnified and inverted; whereas, when the divergent lens is used, the distance between the lenses is equal to the difference between their focal lengths when the rays from the objective converge to the first principal focus of the eye-lens, the final image formed being erect. This arrangement was devised by Galileo, and, being shorter than the former combination, is adopted in the construction of opera glasses that require an erect image.—(C. F. P.)

Eyelids. Lids. Palpebræ. The cartilaginous, cutaneous, and mucous coverings of the eyes. The eyeball is partially protected as well as cleansed by the eyelids. Between the loose folds of skin on the outer surface, and the inner covering of mucous membrane, the conjunctival surface, are found connective tissue plates,—the tarsi, or so-called tarsal cartilages—to stiffen them and to enable them to

retain their form. The lids are closed by the powerful sphincter muscle—the orbicularis; they are opened chiefly by the levator palpebræ superioris above, and by prolongations from the inferior rectus below. See, also, **Anatomy of the human eye**; as well as **Histology of the eye.**

Instead of attempting to describe the numerous and important subsections of this heading under one rubric, the various subjects will be separately treated.

That these subjects may be brought up to date of publication many of them will be further treated under **Lid** headings, to which the reader is referred.

Eyelids, Abscess of the. This occurs most frequently as a result of injury, though it may have its origin from orbital disease. Spontaneous abscess rarely occurs in adults, but is occasionally met with in ill-

Abscess of the Lid.

nourished children. According to Berger, deep abscesses of the upper lid, which have been observed as a result of influenza, may have been due to inflammation of the frontal sinus. If not promptly opened, large abscesses sometimes cause sufficient sloughing to produce considerable deformity of the lid, with lagophthalmos, or ectropion. An abscess situated in front of the lachrymal sac closely simulates dacryocystitis.

In the treatment of abscess of the lid, iced applications in the early stages give relief, but as soon as induration is detected, hot fomentations should be applied. When evidences of pus appear, a free incision, parallel with the fibres of the orbicularis muscle, should be made.

Eyelids, Acne rosacea of the. This condition occurs about the eyelids in severe cases, and is easily recognized by the presence of the trouble in the face. The lids are congested and somewhat chemosed, hence the disease is liable to be chronic. In the treatment of this condition a simple ointment, such as a three to five per cent. sulphur ointment, acts favorably. Lotions should not be used, as they are apt to irritate the conjunctiva. See. also, page 76, Vol. I, of this *Encyclopedia.*

Eyelids, Adenoma of the. This rare form of growth involves the lids (mostly the Meibomian glands) which become nodular, stiff and board-like. Only about ten cases of this condition have been recorded. The mass should be excised and examined microscopically.

Eyelids, Albinism of the. A congenital deficiency of the pigment of the skin, which presents a milky-white color. The appearance is the same as in *vitiligo,* which is an acquired condition. There is no efficient treatment. See **Albinism.**

Eyelids, Aleppo boil of the. DELHI BOIL. BISKRA BUTTON. FURUNCULUS ORIENTALIS. This is a local infectious disease endemic in the tropics, and characterized by the formation of papules, nodules, scabs and punched-out ulcers. The uncovered parts of the face are chiefly attacked, the eyelids often being involved. The disease is inoculable in both men and animals. Laveran attributes its spread to flies. It is a local disease without constitutional disturbance, and occurs among all tropical races, being distinguished from yaws, which presents marked constitutional symptoms and is found almost entirely among the colored races. The prognosis of the disease is favorable. The *treatment* includes the use of the galvanic cautery in the early stage; hypodermic injections of 10 per cent. carbolic solution around the boil, and curettement or the application of caustics, when the process has gone on to suppuration and the formation of granulations. See also **Aleppo button,** Vol. I, page 217, of this *Encyclopedia.*

Eyelids, Alopecia areata of the. This condition of baldness in spots occurs sometimes in the eyelids. *Hysterical alopecia* of the lids is occasionally seen in neurotic females and in hysterical children of both sexes. Such subjects systematically pull out the cilia. Local stimulating applications should be combined with appropriate general treatment.

Eyelids, Alopecia of the. Simple defects of the cilia usually result from chronic blepheritis marginalis and syphilis. A case is, however, mentioned by Morax which he proved to be due to keratosis pilaris.

Four cases of this character were reported by Gifford (*Ophth. Record*, January, 1901) in some of which he questions the propriety of classifying them as hysterical. It was suggested that the trouble was more in the nature of a habit akin to that of biting the nails, although the rapid effect of the mental therapeutics employed contradicts this idea. It is sometimes hard to draw the line between pure meanness or a simple desire to excite sympathy, on the one hand, and well marked hysteria, on the other. See, also, page 249, Vol. 1, of this *Encyclopedia*.

Eyelids, Amboyna button of the. See **Eyelids, Frambesia of the.**

Eyelids, Anakhre of the. This term is applied to an affection characterized by bony tumors on each side of the nose, found among West African negroes. See **Eyelids, Goundon of the.**

Eyelids, Angiofibroma of the. Angiomata constitute rather rare tumors of the eyelids, although the lymphangioma, especially the fibro-

Plexiform Angiofibroma of Eyelid. (Meyerhof.)

matous form of it (elephantiasis, for example) is not uncommon. Meyerhof (*Ophthalmic Record*, June, 1910) has described a case of plexiform angioma of the lids in a young girl, who appeared perfectly strong and healthy. Six years before, a bluish spot was noticed on the upper left lid. This spread until, three years ago, it had grown into a tumor that entirely covered the left eye, excluding the vision, and so disfiguring her that she desired to have it removed. Two attempts to extirpate the new growth were made with the actual cautery, but without success.

The writer says that in its "present condition the bluish tumor is a great disfigurement, as it entirely covers the left eye, forming an

irregular, lobular mass. It involves the whole of the left upper lid and has invaded the tissues about the external angle as well as the temporal portion of the lower lid (see figure). In the upper lid the mass measures 2 x 4 cm., while its thickness is about 1.5 cm. Its consistence is very soft; pressure between two fingers is painless, but reduces the size of the tumor somewhat. The inferior portion of the neoplasm, affecting the cheek and lower lid, measures 3 x 2.5 cm. and is not compressible. A scar, due to a previous cauterization, shows on its surface.''

Most of the tumor mass was excised under chloroform and the wound of operation healed satisfactorily after a delay of seven days. Two secondary excisions, under local anesthesia (for the extirpation of a small remaining portion of the tumor) were made, as well as the electrolysis, a week later, of a superficial vein in the cheek

The microphotograph presents the characteristic appearances of a subcutaneous fibroma containing numerous veins (especially venocavernous plexuses) distributed rather regularly throughout the tumor mass. In other words, we have to deal with a plexiform angiofibroma.

In the absence of a history of traumatism or other recognized etiologic factor, one is constrained to regard this growth as congenital. So far as prognosis is concerned, statistics prove that the radical extirpation of angiofibromas is rarely or never followed by relapse. The cosmetic result of the operation depends, of course, upon the extent to which the lid muscles (which should always be protected as far as possible) are involved in operative procedures undertaken for the removal of the growth. See, also, **Eyelids, Lymphangioma of the.**

Eyelids, Angioma of the. TELANGIECTASIS OF THE LIDS. Several forms of angioma occur in the eyelids. The simple *vascular nevus*, or ''mother's-mark,'' is a congenital condition resulting from excessive development of capillaries, and appears as a bright-red spot, varying in size from that of a pin-head to the entire area of the surface of the lid. It occasionally disappears spontaneously, but is usually permanent. It rarely increases in size.

Telangiectasis consists of a collection of enlarged capillaries, arterioles and venules in the skin and subcutaneous tissue, which may exist at birth but generally appears later, and in either case tends to increase.

Cavernous angioma forms a distinct tumor consisting of cells and sinuses and enlarged vessels, with a framework of connective tissue. It may be congenital but more frequently originates after birth, and is sometimes developed from the preceding variety. These tumors can

generally be emptied by pressure, but occasionally pulsate, if chiefly arterial in character.

Treatment consists in obliteration of the vessels, destruction by cauterization, or removal with the knife. Small superficial nevi may be successfully treated by caustics. In the case of infants, vaccination at several points will often excite sufficient inflammation to obliterate the vessels. A larger growth may be treated by penetrating a fine thermo-cautery needle obliquely under the skin at numerous points around the base. Coagulating injections are not without danger, and ligatures are likely to cause suppuration and leave cicatrices. Cavernous angiomata are frequently encapsulated, when they can be safely enucleated. In other cases removal should be accomplished by incision carried well into the sound skin. A blepharoplastic operation may be necessary. (Harlan.) Carbonic acid snow has been successfully employed in a number of cases. Capauner (*Klin. Monatsbl. f. Augenheilkunde*, Vol. XLIX, Nov., 1911) has used carbonic acid snow very successfully in two cases of large angiomata of the lids in little children. Applications were made at intervals of about ten days to allow all inflammatory symptoms to pass away between treatments. The snow is forced into a small glass tube 1 cm. broad by 1 cm. long and about 1mm. thick, by means of a wooden plug. Pressure upon the plug forces out the snow as desired without danger of injury to the conjunctiva. Toleration is established by the skin after a few applications, so that the time of treatment may be lengthened from thirty to sixty seconds. The author's experience in one case of trachoma leads him to believe that expression and massage with bichlorid solution are superior to applications of carbonic acid snow. Knapp (*Arch. of Ophthal.*, Jan., 1911) reported the case of an eleven-months-old infant with an angioma of the eyelid characterized by thickening of the skin and a mass of large blood vessels. The growth involved the edge of the lid, making excision with the knife undesirable. One application of the carbonic acid snow caused the growth to shrivel up and drop off. Risley (*Ophthalmic Record*, March, 1906) reported the case of an angioma of unusual dimensions, and the method employed in its removal, which is of interest. The patient was an eleven-weeks-old infant, and the tumor occupied about three-fourths of the entire length of the right lower lid. The tumor was soft and fluctuating, but grew tense when the child cried, so that bursting of the much-thinned pellicle of enveloping skin seemed imminent. The method of procedure adopted for its removal is thus described by Risley: "A single electrolytic needle was inserted at many points into the base of the tumor, at first superficially, and gradually made to penetrate its mass more deeply,

but only in its deeper portion, in order to secure a firm coagulum, first in the region of the emerging vessels at its periphery, and then over the entire base. Under the electrolysis the entire mass became hard, lost its fluctuating quality and shrank. The surface was then covered with a thick coat of collodion. In forty-eight hours the rounded, overhanging borders, had disappeared, the surface was corrugated and much flattened. In a week the electrolysis was repeated, and later with multiple needles three times at intervals of a week or ten days, but without any marked improvement beyond that secured by the first attempt. The tumor remained hard and quite dense at the center, but showed an unmistakable tendency to spread laterally, and it became obvious that some more radical procedure was required if a cure was to be effected. Deep electrolysis was again repeated and the following day an Ericson's suture was introduced. A large curved needle with an ample eye was threaded with one black and one white heavy silk thread a yard long. Beginning at the nasal extremity of the tumor, the suture was carried vertically upward through it, being careful to include the mass down to the surface of the lid cartilage, but not including it. Then reversing the procedure, the thread was carried through the mass downward to a point 5 mm. from the first, and so back and forth until the entire tumor was enclosed in a series of loops, above and below. The extremity of the loops of white thread were then cut above, leaving them intact below. They were then drawn tightly home and tied. The black loops were then cut below and in a like manner brought firmly home and tied, in this manner effecting a complete strangulation of the entire mass, which sloughed off in about a week without hemorrhage, leaving a granulation mass at each extremity. These were also removed by strangulation with a silk thread, after which the surface cicatrized rapidly, manifesting but little tendency to cause ectropion." See, also, **Tumors of the eye.**

Eyelids, Angiomegaly of the. In certain forms of senile ptosis, the essential features are atrophy of the derma and of the elastic fibres, with enlargement of the blood-vessels. To this condition has recently been applied the foregoing term. See, also, **Ptosis.**

Eyelids, Angiosarcoma of the. This form of sarcoma, as well as the alveolar variety, occurs at times in the lid. According to Parsons, they are probably endotheliomata. About one half of the cases are pigmented. The following case was reported by Claiborne (*Ophthalmic Record,* June, 1907). A strong, healthy boy, 13 years of age, during two months' time, developed a red, pedunculated tumor the size of a small peanut from the cutaneous surface of the lower lid about 1 mm. below the edge of the conjunctiva, between the punctum

Angiosarcoma of the Lid. (Claiborne.)

Angiosarcoma of the Lid. (Claiborne.)

and the wall of the nose. The tumor was corrugated and bled easily. The eyeball was unaffected. An attempt was made to excise the tumor without general anesthesia, but was only partially successful. A second effort was later made to excise the remaining portion, but recurrence of the tumor and a report from E. B. Coburn that it was an angiosarcoma warranted an operation under ether. When the tumor area was freely cauterized the part healed in two weeks, leaving a white scar. See, also, **Eyelids, Endothelioma of the.**

Eyelids, Ankyloblepharon of the. Adhesion of the lids along the palpebral margins. It may be partial or total; is rarely congenital, but usually results from ulcerations, burns, or other injuries. It has occasionally occurred after croupous conjunctivitis. It may occur alone but more frequently symblepharon also is present. A few cases have been observed in which at birth a filiform band passed from one lid to the other. See page 486, Vol. I, of this *Encyclopedia.*

Eyelids, Anomalies of the. CONGENITAL DEFECTS OF THE EYELIDS. The eyelids are the subjects of a variety of congenital anomalies, both as to structure and innervation. For a complete account of these, see Vol. IV, p. 2776, of this *Encyclopedia.*

Eyelids, Anthrax of the. MALIGNANT PUSTULE. This disease, due to inoculation with the anthrax bacillus, may involve the eyelids.

A case has been reported by Leplat, Riviere and Bettremieux (*Clin. Opht.*, V. 19, p. 624). It is chiefly of interest from the point of view of diagnosis, inasmuch as anthrax of the lids is not infrequently taken for gangrenous erysipelas. The patient, a man of 24 years, worked in a wool factory. The eschar was surrounded by the usual halo of vesicles. Bacteriologic examination and culture were negative, but the beginning of the disease in a small swelling surmounted by a vesicle, the febrile reaction, and the characteristic deep-black color of the eschar left no doubt as to the diagnosis. See Vol. I, p. 512, of this *Encyclopedia.*

Eyelids, Argyria of the. Staining of the eyelids by nitrate of silver is but rarely seen. See Vol. I, p. 574, of this *Encyclopedia.*

Eyelids, Arteries of the. See **Eyelids, Blood-vessels of the**; as well as **Anatomy of the eye.**

Eyelids, Asteatosis of the. A deficiency of the secretion of sebum. In pronounced cases ectropion may result. The prognosis as to permanent improvement is unfavorable, but the best results follow the regular application of animal fats and the internal administration of arsenic.

Eyelids, Auto-eversion of the. This must be a rare although apparently trivial anomaly of the eye. Santos Fernandez (*Anales de Oft.*,

XIV, p. 323, 1912) observed a boy of eight years who was able to turn the upper lid of the right eye with the help of one finger, but could turn the left upper lid without touching it. The edge of the upper lid was apparently pushed up by the edge of the lower lid during vigorous contraction of the orbicularis.

Eyelids, Blastomycetic dermatitis of the. This is a local infective process, rare in occurrence, and chronic in character, which often involves the eyelids. The lesion begins as a papule or papulo-pustule and slowly enlarges peripherally in the form of an indolent, flat, wart-like or crusted papule (Montgomery). The surface presents irregular papilliform elevations between which pus oozes on pressure. The bor-

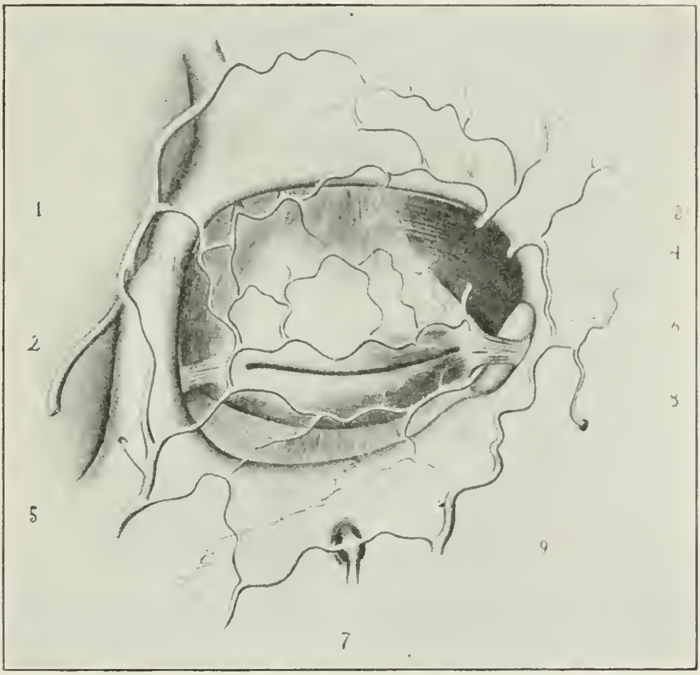
Blastomycetic Dermatitis Involving the Eyelids. (Walker.)

der is of a purple or reddish color, and is studded with minute abscesses. The disease may remain indolent for months or years, with occasional exacerbations. The lesions may heal centrally while extending peripherally. When involving the eyelid, the disease causes ectropion. (See figure.) Blastomycetic dermatitis is to be differentiated from syphilis, carcinoma, lupus vulgaris and verrucous tuberculosis. The characteristic features are the miliary abscesses and the presence of distinct budding organisms seen on microscopic examination. The treatment includes excision of the diseased areas, the internal use of large doses of potassium iodid, and the use of the x-rays. Cleansing or antiseptic washes or dry dressings can be used locally with benefit. —(J. M. B.)

For a more extended account of this disease, as it affects the eye as a whole, see Vol. II, p. 1008, of this *Encyclopedia*.

Eyelids, Blepharitis of the. For a description of the numerous forms of this disease see Vol. II, p. 1022, of this *Encyclopedia*.

Eyelids, Blood-vessels of the. The *arteries* of the eyelids are the internal and external palpebral, the former being derived from the ophthalmic and the latter from the lachrymal. The vessels pass from the outer and inner angles toward the centre of the lid, forming an arch, the *tarsal arch,* along the edge of the lids. A second

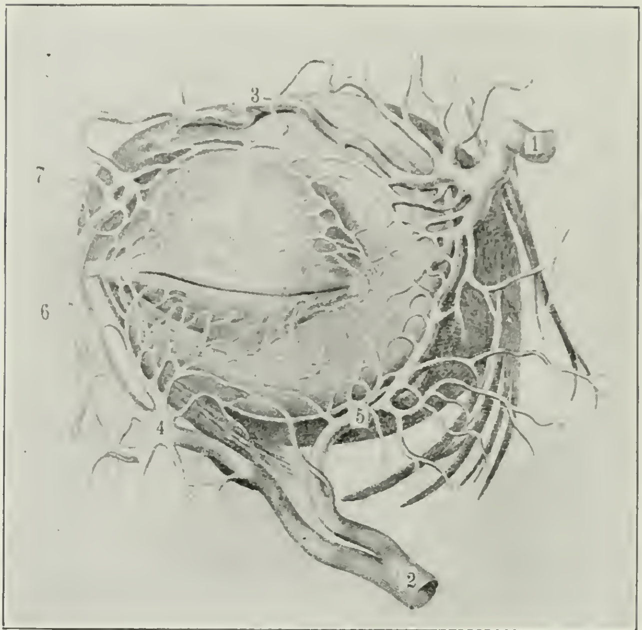


Arteries of the (Right) Eyelids. (Ball.)
(Original drawing by R. W. Mills.)

1, Anastomosis between the lachrymal and superficial temporal. 2, Superficial temporal. 3, Supra-orbital. 4, Fronto-nasal. 5, Transverse facial. 6, Superior palpebral. 7, Infra-orbital. 8, Inferior palpebral. 9, Facial.

arch, the *external tarsal arch,* is found in the upper eyelid, where it runs in front of the upper edge of the tarsal plate. The same arrangement is found in the lower lid. The tarsal arches are joined by small anastamosing branches. (See figure.)

The *veins* of the eyelids are disposed in two series: the pre-tarsal and the post-tarsal. The former empty into the superficial temporal



Veins of the (Left) Eyelids. (After Soemmering.) (Ball.)
1, Branch to the deep temporal vein. 2, Facial vein. 3, Supra-orbital. 4, Angular. 5, Branch connecting the temporal and facial. 6, Dorsal vein of the nose. 7, Frontal vein.

and facial veins, while the latter pass into the ophthalmic vein. (See figure.) See, also, **Anatomy of the human eye**; as well as Vol. II, p. 1228, of this *Encyclopedia*.

Eyelids, Botryomycosis of the. A small tumor in the middle of the margin of the upper lid was observed by Faber (*Nederlandsche Oogheelk*, 1897, 3, p. 24) which contained nodules, each of which presented a small opening, from which a mucoid, granular mass could be expressed. The small spherical granules consisted of the fungus botryomyces. See Vol. II, p. 1253, of this *Encyclopedia*.

Eyelids, Burns of the. These are of importance on account of the danger of disfigurement produced by cicatricial contraction after extensive destruction of lid-tissue, and of the complication with burns of the surface of the globe. They are commonly caused by hot water, caustics, acids, or from the explosion of gun-powder. When the burn is slight, the simple application of oil, with a light moist dressing of carbonate of soda to relieve the pain will suffice. In severe burns the entire thickness of the lid may be involved, and the cornea damaged. Various degrees of ectropion or of symble-

pharon may be produced, necessitating operative treatment to relieve the condition. In the case of powder burns all loose powder should be immediately removed and, if possible, each grain picked out of the skin with a fine needle, or destroyed with an electrocautery needle, as recommended by Jackson. Peroxide of hydrogen has been efficiently employed to remove powder grains. It may be applied in full strength or in a solution of three parts to one of glycerin. See **Eyelids, Injuries of the**; also Vol. II, p. 1346, of this *Encyclopedia.*

Eyelids, Cancroid ulcer of the. RODENT ULCER. JACOB'S ULCER. See Vol. II, p. 1381, of this *Encyclopedia.*

Eyelids, Canities of the. POLIOSIS. The absence of pigment in the cilia, without other recognizable lesion. See Vol. II, p. 1382, of this *Encyclopedia.*

Eyelids, Carbuncle of the. See Vol. II, p. 1406, of this *Encyclopedia.*

Eyelids, Carcinoma of the. See Vol. II, p. 1410, of this *Encyclopedia.*

Eyelids, Cavernous angioma of the. See Vol. II, p. 1794, of this *Encyclopedia;* as well as **Tumors of the eye.**

Eyelids, Chancre of the. About one case in twenty-five of syphilis is due to an extragenital primary lesion, so the chance of the lid becoming affected is very small. The sore usually appears near the lid margin. See Vol. III, p. 2003, of this *Encyclopedia.*

In Kowalewski's case (*Centralbl. f. p. Augenh.*, Jan., 1908) a sore, 1 cm. long and 0.5 cm. wide with indurated edges, was situated at the nasal half of the upper fornix. Scrapings showed spirochetæ. The aural and maxillary glands were enlarged. The wife of the patient was syphilitic. In Zazkin's case (*Roussky Vratch*, No. 28) although no spirochetæ were found, secondary symptoms followed.

Rollet and Genet (*Revue Générale d'Ophtal.*, April, 1912) describe the case of a man twenty-two years of age, no hereditary taint, with two chancres of the face. The one on the lower left lid embraced practically that entire structure. The other was situated at the outer angle of the mouth, not involving the mucous membrane, oval in shape and about 25 x 14 mm. The glands were swollen so that some were visible upon inspection. Date of contamination was not obtainable, but seemed to have taken place through acne pustules. Next day a roseolar eruption appeared, and the *treponema pallidum* was isolated. The patient received 0.5 grm. arsenobenzol, and twelve days later a similar dose. Two weeks later, the chancres had cicatrized and the roseola disappeared.

The observation is absolutely classic as to the course of the disease and is cited to remark upon accidental initial lesions. This case, by

having two points of entry upon the face, is also noteworthy. Both improved simultaneously under treatment and were healed in fifteen days. The arsenobenzol was given by rectum, dissolved in 300.0 grains of artificial serum, to which was added twelve drops of laudanum, and introduced high up by means of a soft catheter. The injections were twelve days apart.

The authors do not consider syphilis with the chancres on the face as severe as infection at other points. See, also, **Chancre of the lid.**

Eyelids, Chloasma of the. A pigmentary hypertrophy sometimes seen during the course of uterine diseases, and in pregnancy. See Vol. III, p. 2062, of this *Encyclopedia.*

Eyelids, Chromidrosis of the. PALPEBRAL CHROMIDROSIS. SEBORRHŒA NIGRICANS. This formation of a variously colored secretion from functionally disordered sweat-glands is sometimes located upon the eyelids. Here it consists of a bluish-black discoloration, usually upon the lower lid, which is somewhat oleaginous. It is probably genuine in rare cases, but is most commonly found in neurasthenic and hysterical women; occasionally in malingerers. See, also, Vol. III, p. 2206, of this *Encyclopedia.*

Eyelids, Colloid degeneration of the. A very rare affection which may involve the forehead, bridge of the nose, eyelids, and at times the conjunctiva. See Vol. IV, p. 2327, of this *Encyclopedia.*

Eyelids, Coloboma of the. See **Congenital anomalies of the eye.**

Eyelids, Congenital abnormalities of the. See **Eyelids, Anomalies of the.**

Eyelids, Congenital growths of the. The lids may be the seat of congenital growths, such as moles, nevi, and cysts. The nevi may be either lymphatic or vascular. Both forms tend to increase in size after birth. Lymphatic nevi are rare; at times they are very large, extending into the orbit and involving the conjunctiva. See **Congenital anomalies of the eye,** Vol. IV, p. 2776, of this *Encyclopedia.*

Eyelids, Congenital ptosis of the. See **Congenital anomalies of the eye.**

Eyelids, Contusion of the. Immediately following this form of injury there is an extravasation of blood into the cellular tissue, producing what is commonly known as "black eye." The effused blood may be in the form of a diffused ecchymosis, or as a hematoma. In some cases of fracture of the base of the skull or in rupture of the orbital vessels, the ecchymosis of the lids develops later. The ordinary "black eye" disappears in two or three weeks. See **Black eye**; as well as **Eyelids, Injuries of the,** and **Ecchymosis of the lids.**

Eyelids, Cornu cutaneum of the. A small cutaneous horn which gen-

erally involves the lower lid. See Vol. V, p. 3524, of this *Encyclopedia.*

Eyelids, Cyanosis of the. In grave cases of cholera, the skin of the eyelids from the first moment is bluish (cyanosis). On account of the weakness of the orbicularis muscle, as well as from the contraction of the cellular tissue of the orbit, it is difficult to keep the eyes closed, and they remain half open. See Vol. V, p. 3606, of this *Encyclopedia.*

Eyelids, Cysticercus of the. This may develop without inflammatory symptoms in the form of a round, elastic, movable tumor resembling an ordinary cyst. It may involve either eyelid or may be found beneath the skin of the eyebrow. It is of exceedingly rare occurrence. See Vol. V, p. 3661, of this *Encyclopedia.*

Eyelids, Cyst of the. See **Cyst formation in the lid**; as well as **Cyst, Sebaceous, of the eyelid,** in Vol. V, of this *Encyclopedia.*

Eyelids, Dermatitis of the. Various forms of dermatitis when appearing on the face may also attack the eyelids. An account of the chief of these will be found under **Dermatitis, Ocular relations of.**

Eyelids, Dermoid cysts of the. The usual site of these tumors is the region of the external angular process of the frontal bone, but they seldom occur in the eyelids. In exceptional instances they are located at the inner angle of the upper lid, in which situation they may have a pedicle connected with the dura mater, resembling a meningocele, in that the brain pulsation is communicated to it. Dermoids of the upper lid, when not connected with bone or periosteum, are stated by Sutton to arise in the fissure between the fronto-nasal plate and the fold of skin from which the lid is formed. Dermoids are to be treated by excision. See, also, p. 3841, Vol. V, of this *Encyclopedia;* as well as **Tumors of the eye.**

Eyelids, Development of the. See p. 3913, Vol. V, of this *Encyclopedia.*

Eyelids, Discoloration of the. This is sometimes seen as a result of the internal administration of drugs, or by accident. The internal use of nitrate of silver has been followed by staining of the lids **(Argyrosis).** An excess of iron present in the system sometimes results in staining, in the form of small brown spots **(Siderosis).** The accidental deposit of grains of gun-powder frequently causes a *tattooing* of the eyelids.

Eyelids, Diseases of the. Owing to the complexity of structures entering into the formation of the eyelids, they show many symptoms pertaining to general diseases. The eyelids are also subject to congenital anomalies, tumors, inflammations, degenerations, infiltrations, etc. All of these are discussed under their proper captions, especially under **Blephar**-headings.

Eyelids, Drooping of the. Ptosis. This defect may be either congenital or acquired, partial or complete, unilateral or bilateral. See **Ptosis.**

Eyelids, Ecchymosis of the. Black-eye. An extravasation of blood into the subcutaneous cellular tissue of the lids. It is most frequently caused by direct violence, as from a blow of the fist, or from a fall. It may be induced spontaneously by excessive exertion and severe paroxysms of coughing. Because of the thinness of skin in this locality and the loose areolar tissue, the effused blood spreads rapidly before coagulation takes place, producing an extensive discolored area. At first of a dark-blue or purple color, the affected area changes during the process of absorption to violet, then to yellowish-green, remaining visible for about two weeks as a faint coffee-colored or yellowish stain. There is usually some swelling of the eyelid present, causing difficulty in opening the eyes. Occasionally the blood is not absorbed and an abscess forms in the lid.

Injury to some remote region of the head, especially a fracture of the base of the skull, may be followed several hours later on by ecchymosis of the lids. In some instances a hematoma is produced, as in the case reported by Jannulis (*Klin. ther. Woch.*, 1912, No. 45) in which during an operation for the removal of nasal polypus, a rather profuse hemorrhage occurred, necessitating tamponage. Soon afterwards the patient experienced pain in the eye, associated with swelling of the upper lid, going on to a complete hematoma. The complication was probably due to retrograde stasis because of the tamponade of a severed anomalous vein. See, also, p. 4122, Vol. VI, of this *Encyclopedia.*

Poulard and Canque (*Ann. d'Ocul.*, Feb., 1911) observed subconjunctival ecchymosis which followed powerful compression of the thorax. The case was noteworthy for its intensity, and persistence even after the disappearance of all cyanosis of the face.

Eyelids, Ectropion of the. See Vol. VI, p. 4140, of this *Encyclopedia.*

Eyelids, Eczema of the. This affection occurs in the same forms and from the same causes as upon the skin in other parts of the body. See Vol. VI, p. 4147, of this *Encyclopedia.*

Eyelids, Edema of the. This is of common occurrence, often seen following trauma, and is a frequent accompaniment of inflammation of the conjunctiva or infection after operations on the globe. It may follow attempts to probe the lachrymo-nasal duct or the injection of fluids into the adjacent tissues. It occurs in cardiac and renal diseases, arsenical poisoning, malaria, etc. In these conditions the swelling is pale and translucent, as contrasted with that due to inflammatory conditions, when it is reddish, opaque, tense, and shining. As edema is

only a symptom, the treatment will depend upon the underlying cause. When so extensive as to prevent opening of the eye, it can be relieved by puncture and the use of a compress bandage.

Sedwick (*Jour. Ophth. and Oto-Laryngol.*, Jan., 1911, p. 17) reported a young woman whose lids swelled intermittently, accompanied by redness of the globes. No sinus involvement could be discovered in this case. See, also, Vol. VI, p. 4155, of this *Encyclopedia*.

Eyelids, Elephantiasis of the. See Vol. VI, p. 4279, of this *Encyclopedia*.

Eyelids, Emphysema of the. The presence of air in the cellular tissues of the eyelids is produced by a communication between the subcutaneous tissue and the neighboring air-cavities, the lachrymal, nasal, frontal, or maxillary. See Vol. VI, p. 4301, of this *Encyclopedia*.

Eyelids, Endothelioma of the. See Vol. VI, p. 4312, of this *Encyclopedia*.

Eyelids, Entropion of the. Turning in of the eyelids, so that the lashes rub on the globe, is generally caused by trachoma. It also follows diphtheritic conjunctivitis, and essential shrinking of the conjunctiva. A muscular form of entropion is seen as a result of bandaging in elderly people, whose eyes lie deeply in the orbits. The presence of foreign bodies in the eye, and the irritation accompanying conjunctivitis and keratitis may cause a spasmodic entropion. Excessive development of the orbicularis muscle may produce an entropion at birth. The effect of entropion is to place the skin of the lid in contact with the globe. The constant rubbing of the lashes against the cornea produces characteristic changes in that tissue. The epithelium becomes abraded and the deeper layers of the cornea become necrotic. Pannus develops and vision is much reduced. See Vol. VI, p. 4331, of this *Encyclopedia*.

Eyelids, Epithelioma of the. Carcinoma in the form of skin-cancer or epithelioma is one of the commonest tumors of this region. It usually begins at the margin of the lid, more frequently on the lower lid and at the inner canthus, whence it extends to the upper lid. In the beginning it appears as a small elevation, the apex of which at first becomes scaly, and may soon be covered with a light crust. There is sometimes a watery, viscid secretion, or occasionally a sanious fluid, which forms a brownish crust. Beneath this crust appears a superficial, grayish excavated ulcer with a slightly raised base surrounded by induration. There is a development of epithelial processes which grow down into the subcutaneous tissue. Masses of epithelial cells are found growing in the deeper structures, entirely separate from the primary processes. Circular masses of cells (whorls) are met with in various parts of the growth. The disease generally progresses very

slowly, but sooner or later the neighboring lymphatic (pre-auricular, submaxillary) glands are involved. The process extends and ends in death by hemorrhage or exhaustion. In the early stages there is but little pain; later, when the destruction of tissue is extensive, the suffering is severe. The disease occurs chiefly in persons past middle age, and in men more frequently than in women.

Epithelioma is to be differentiated from lupus, syphilitic gummata and nodules, rodent ulcer, chancre, and tuberculosis. It may be confounded with molluscum contagiosum. Epithelioma is peculiar to advanced adult life, whereas lupus is a disease of youth, and the history is decidedly different. In syphilitic processes the progress of the disease is usually rapid and there is a history of infection. In gummatous ulceration there is no hardness around the ulcers, which are multiple and punched out, and present an abundant purulent discharge. In epithelioma the process is slow and the discharge scanty, thick, and bloody. Chancre may be differentiated by its history and rapid development. A broad, flat, slowly-growing epithelioma which has destroyed the lid-margin and invaded the conjunctiva, which presents a mammillated appearance, may so closely resemble tuberculosis that only a microscopic examination can determine the diagnosis.

In the treatment of epithelioma excision in the very early stage of the growth is followed by excellent results. In advanced cases palliative measures only are advisable. The Roentgen ray, Finsen's light, and the use of radium should be mentioned among the more recent methods of treatment which have shown encouraging results. Hirsch (*Klin. Monatsbl. f. Augenh.*, Aug., 1911) reports most satisfactory results in one case, from the combined Roentgen-radium treatment. An instructive paper by Zentmayer (*Ophth. Record,* Aug., 1907) relates how the ulcerating skin surface of the lower eyelid, following the removal of a mole eight years before, healed completely after application of powdered potassium chlorate. Subjecting the growth to the influence of radium bromide has been followed by some excellent results, where the growth has not involved the deeper structures to any great extent. If left to itself epithelioma is fatal.

Bialetti (*Ann. di Ott.*, V. 41, p. 526) reports the cure of two cases of lid epithelioma with jequiritin. One tumor was a phagedenic epitheliomatus ulcer at the outer canthus, extending on to the upper and lower lids. Rampoldi's jequiritin discs No. 2 were applied at intervals suited to the duration of the previous reaction, and continued for a period of four weeks. In the second patient the tumor had recurred after surgical removal a year earlier, and was a fungoid, sessile epithelioma at the center of the lower lid, ulcerated at its center. The

jequiritin discs were applied to the raw surface after removing the mass with a bistoury, and the treatment lasted forty days. The report was made in the latter part of 1912, the first case having been treated in 1910 and the second in 1911, and so far there had been no recurrence. See **Epithelioma**, as well as **Tumors of the eye.**

Eyelids, Erysipelas of the. This disease rarely begins in the eyelids, though they are usually involved by extension from the face or some part of the head. It is characterized by a diffuse cellulitis caused by the streptococcus. The lids become much swollen, of a dusky-red color, and are stiff and painful. The swelling is at times so great as to extend over the brow and cheek. Conjunctivitis and chemosis are sometimes present. By extension into the orbit the disease may cause exophthalmos, atrophy of the optic nerve, and even meningitis and death.

Erysipelas may be confounded with an inflammatory condition of the lachrymal sac. Tenderness over the sac and fluctuation will serve to differentiate between the two. Traumatic swelling and herpes zoster in the early stages may also be mistaken for erysipelas. The prognosis in the majority of the cases is good. The general and local treatment is the same as that for erysipelas located elsewhere. Moist compresses of lead and opium wash, or the application of ichthyol are among the best local remedies. See, also, Vol. VI, p. 4510, of this *Encyclopedia.*

Eyelids, Erythema of the. The skin of the lids may at times become reddened, dry and painful, as a result of exposure to strong wind, glare of light, prolonged weeping, wakeful nights, excessive strain or use of the eyes, particularly when errors of refraction are uncorrected, burns, poisoning, traumatism, or the presence of irritating fluids. Although these cases properly belong to the domain of the dermatologist, they frequently fall into the hands of the oculist on account of the concomitant conjunctivitis which requires attention. The hyperemia may be active or passive. In active hyperemia, which is the first stage of all inflammations of the lids, the arteries and capillaries are overfull. In the passive form there is venous stasis, and the color is somewhat darker than in the active form. Idiopathic erythema of the eyelids is rare. The affection is generally transient, disappearing spontaneously in a few days, but occasionally more persistent and sometimes recurrent. Treatment must be directed to the cause. See, also, Vol. VI, p. 4514, of this *Encyclopedia.*

Eyelids, Eversion of the. See Vol. VI, p. 4584, of this *Encyclopedia.*

Eyelids, Examination of the. See **Examination of the Eye.**

Eyelids, Favus of the. This disease, which is exceedingly rare, first shows itself as yellowish-red, painful vesicles. Later there is a dry, fissured crust, elevated above the level of the surrounding skin. The

crust is of a sulphur-yellow color, with a central depression, and showing a variety of colors varying from white to sepia brown. Microscopic examination shows the presence of the sporidia and mycelia of achorion Schoenleinii. Treatment consists in the use of an oiled compress in the evening, and frequent washings with bichlorid solution (1 to 4000).—(J. M. B.)

Eyelids, Fibroma of the. This disease, consisting of bundles of densely packed fibrous tissue containing numerous blood-vessels, may be found in the lid as a small, hard, rounded mass, freely movable, and not tending to increase in size. Several forms of fibromata occur. The "painful subcutaneous tubercle" is situated in the connective tissue immediately under the skin. These little tumors are painful and sensitive to the touch. They were first described by Wood in 1812 (*Edin. Med. and Surg. Journ.*, p. 283). Fibromata of the lid sometimes assume the form and consistence of plates of cartilage. Von Graefe (*Klin. Monatsbl. f. Augenheil.*, Jan., 1863) described a tumor, situated in the cul-de-sac, which contained true bone. Fibroma molluscum involving the skin and the subcutaneous connective tissue may form an extensive pendulous tumor in the loose and distensible integument of the lid. The treatment of these tumors is by removal.

Eyelids, Fissures of the. Rhagades. In cases of eczema, and in those types of ocular diseases accompanied by photophobia and blepharospasm, fissures of the external canthus are often present. The condition is relieved by the application of nitrate of silver, either in the form of a strong solution or the solid stick, to the raw spots. Canthotomy may be required in obstinate cases.—(J. M. B.)

Eyelids, Fistula of the. This is a rather rare condition, due to nonclosure of the fronto-maxillary fissure; or it occurs as a remains of a frontal sinus abscess that has broken through the palpebral skin.

Eyelids, Frambesia of the. Yaws. Amboyna button. Pian. This is a contagious disease seen in tropical climates, characterized by the presence of raspberry-like nodules in the skin and by more or less constitutional disturbance. The papules undergo suppuration and scabbing, with the formation of a slight scar. In some instances there is serious ulceration of the skin and subcutaneous tissues. The entire course of the disease occupies several months. The eruption, which begins on the face and extends downward, may involve the eyelids, leading to localized thickening, conjunctivitis, and sometimes necrosis. The disease is to be differentiated from small-pox and the lesions of hereditary syphilis. Its marked resemblance to blastomycetic dermatitis has been noted. The prognosis is generally favorable. The treatment includes improved hygienic surroundings, tonics, diaphoretics, and local

applications of carbolic-acid lotion or the diluted nitrate of mercury ointment.—(J. M. B.) See, also, **Aleppo button**, Vol. I, p. 217, of this *Encyclopedia*.

Eyelids, Freckles of the. LENTIGO. Small circumscribed spots of pigment occur on the eyelids as well as on other exposed portions of the skin. They may be congenital, but they usually occur about the second decade of life.

Eyelids, Furuncle of the. This form of localized inflammation of the skin and subcutaneous tissue, due to infection by one or more of the pus-cocci, is occasionally seen upon the eyelids. The local use of an ointment of salicylic acid (gr. xv to ℥ i), and the occasional application of cloths wrung out of hot water, will be appropriate. An incision may be necessary in neglected cases.

Eyelids, Furunculus orientalis of the. ORIENTAL BOIL. ALEPPO BOIL. DELHI BOIL. BISCARA BUTTON. GAFSA BUTTON. KANDAHAR SORE. PUEDJEH SORE. NATAL SORE. A local disease, common along the shores of the Mediterranean sea, marked by the successive formation of papule, tubercle, scab, and sharply circumscribed ulcer. See Vol. I, page 217, of this *Encyclopedia*.

Eyelids, Gangrene of the. SPONTANEOUS GANGRENE. PHAGEDENIC ULCERATION. MALIGNANT EDEMA. NOMA. This rare condition has been observed by several writers. The disease appears in emaciated infants and children, and is characterized by swelling of the lid, the formation of a pimple, which is soon converted into a pustule and is followed by ulceration, and the presence of a thin conjunctival discharge. The skin, conjunctiva, and intervening structures soon break down, and may be partly or entirely destroyed. The ulcer presents sharply-defined, undermined edges, bordered by a zone of darkly-congested skin. There is greenish pus and a dirty slough. The cornea is opaque and ulcerated and perforation results. The ulceration may spread into the eyebrow and on to the cheek. The bacterial cause of the disease has not been determined. The prognosis will depend on the time when the patient is brought for treatment and on the general condition. The treatment consists in cleansing and antiseptic applications, and supportive measures internally. The administration of diphtheria antitoxin has been recommended. A case following an attack of diphtheria was reported by Marlow (*Ophth. Rec.*, Dec., 1901) in which there was complete destruction of both the upper and lower lid, including skin, conjunctiva, and all the intervening structures.

Cases of gangrene of the eyelids, as a sequel of measles, have been recorded. Fieuzal (*Centralblatt f. prakt. Augenheilk.*, 1887) described this condition. Stoewer (*Klin. Monatsbl. f. Augenheilk.*, July, 1908;

review in *Oph. Review*, Oct., 1908) describes a case of partial gangrene of the lid, with consequent hemorrhagic diathesis. The case cited is that of a three-year-old child in whom a small ulcer developed on the right lower lid margin. The child had just recovered from measles. A few days after the ulcer was noticed the lower lid became much swollen and the skin over it dark-blue in color. At the same time there was a constant trickling of blood from the lid aperture. Examination under chloroform showed that the bleeding came from the general conjunctival surface, no eroded spot being found. Compression failed to stop the bleeding and Stoewer contented himself with a slight application of nitrate of silver to the conjunctiva and the use of a wet dressing. Within the next few days the submaxillary lymph glands became much swollen and hemorrhages were observed on the mucous membrane of the tongue and in the skin. Eventually the child made a good recovery, and though a triangular area sloughed from the edge of the lid, little deformity was left. Stoewer looks upon the whole process as a local and general sepsis due to the staphylococcus aureus which was found present in the lid ulcer. There was no suspicion of hemophilia, and Stoewer considers the hemorrhagic tendency was the effect of the septic process. The disease ran the course of a case of typical morbus maculosus Werhoffi (purpura hemorrhagica).

In Bergmeister's case (*Ophthalmic Year Book*, p. 283, 1909) gangrene affecting particularly the lower lid occurred in conjunction with ophthalmia neonatorum. Gonococci and streptococci were present. The reporter ascribes the affection to the circulatory disturbance caused by the great tension and swelling of the lids for a week before advice was sought. Tertsch reports a case of gangrene of all four lids in a new-born syphilitic infant. Francke observed gangrene of the upper and lower lids of both eyes in an infant followed by good recovery. No cause could be found other than a cold and damp dwelling house; he accordingly denominated the affection "noma."

Bossalino (*Ann. di Ott.*, V. 41, p. 610) reports the case of a healthy man of 20 years, who received a slight blow on the right upper lid. The following night the lid began to swell, and the patient had a chill. Three days later there was intense edema of the lids, affecting especially the upper, and extending on to the forehead, cheek and neck. The upper lid was covered by a large black eschar, which reached from the superciliary ridge to just short of the ciliary margin. For the following three days the temperature was constantly elevated, reaching a maximum of between 102 and 103 degrees each day. Three weeks from the onset of the affection the necrotic tissue was excised

Extensive plastic work was necessary. Bacteriologic study was negative, with the exception of a few white staphylococci, but the author believes the condition to have been due to the streptococcus. It seems not unlikely that this case may have been one of anthrax.

Jarnatowski (*Ophth. Rev.*, V. 32, p. 262) describes a case of necrotic tarsitis, without antecedent inflammation of the conjunctiva. The slough, which measured 2 or 3 mm. by 10 mm., was easily removed with forceps, and smooth healing followed. The necrotic tissue included tarsus and acini of the Meibomian glands.

Eyelids, Goundon of the. ANAKHRE OF THE LIDS. GROS NEZ. This is a rare disease, found on the West coast of Africa. It occurs in childhood, usually begins with headache, and is characterized by a sanguinopurulent discharge from the nostrils, and the formation of symmetrical swellings on the side of the nose, involving apparently the nasal process of the superior maxilla. The enlargements encroach upon the orbits and finally destroy the eyes.

Eyelids, Granuloma of the. The mass of granulation tissue which results from inflammation of the Meibomian glands received from Virchow the name of granuloma. See **Chalazion**, Vol. III, p. 1983, of this *Encyclopedia*.

Eyelids, Gumma of the. Tertiary syphilitic lesions are most frequently seen as a general thickening of the lid, a "tarsitis;" while a gumma, which is a circumscribed tumefaction, is the rarest of all specific lesions.

The lids become swollen and tense. Ulceration follows, the ulcer having an irregular, eroded, "punched-out" appearance. Its floor is covered with dirty-yellowish, or gray, débris, and if unchecked there may be extensive destruction of the tissues. In the absence of a history of infection the diagnosis may be difficult. The prognosis of gumma of the lid is favorable, the condition yielding to iodid of potassium internally and mercurial salve locally. Cauterization is contra-indicated. When seen before necrosis takes place, gummata bear a very strong resemblance to chalazia, but nearly always progress toward the skin and leave the conjunctival surface normal. The conjunctiva and cornea may, however, be involved, as in a case reported by Clapp (*Ophth. Record*, June, 1912) in which there developed a small ulcer of the conjunctiva close to the limbus, which gradually extended until it involved the cornea for about 2 mm. with superficial ulceration. This condition healed very rapidly as soon as treatment was begun.

While the syphilitic tarsitis is usually a painless condition, those reporting gummata have generally found it associated with considerable pain. De Wecker (*Traité d'Ophtalmologie*, Vol. I) reports such a case, which he mistook for chalazion, which was very painful;

while Bull (*Trans. Amer. Ophthal. Soc.*, 1878) reported a case of gumma of the left lower lid the size of a robin's egg, with little or no pain. See, also, **Eyelids, Syphilis of the**; also **Syphilis.**

Eyelids, Gunpowder grains in the. TATTOOING OF THE LIDS. If the patient is seen shortly after an explosion of powder the black grains of powder can be removed by scrubbing with a nail-brush. Tattooing of the eyelids from grains of gunpowder is of comparatively frequent occurrence. After the carbonized particles have stained the integument, puncture with the electrolytic needle will give satisfactory results. The continued use of gauze soaked in hydrogen peroxid, if applied soon after the accident, is said to be of value. See, also, **Eyelids, Injuries of the.**

Eyelids, Hernia of the. In elderly persons, as a result of atrophy, or from trauma during any period of life, the fatty tissue of the orbit, which is normally held in place by the tarso-orbital fascia, orbicularis muscle, and skin, may protrude between these weakened tissues. The hernia can be pushed back into the orbit, or if of sufficient size to cause deformity, the protruding tissue may be removed through an incision made parallel with the fibres of the orbicularis muscle.

Eyelids, Herpes of the. Herpes of the fifth nerve occurs in both sexes with almost equal frequency, and attacks adults as a rule, although it is not rarely observed in children and young subjects with apparently unimpaired nutrition. The vesicles occur in patches of three or more, having a tendency to group in a round form. They appear in the temporal region, on the forehead, upper lid, conjunctiva, and cornea. The lower lid and cheek are rarely involved in the eruption. See **Herpes zoster ophthalmicus.**

Eyelids, Hives of the. URTICARIA. This inflammatory disorder of the skin often involves the eyelids. It is characterized by the presence of wheals, with a sensation of burning and itching. It is seen to follow eye strain or upon improperly corrected errors of refraction, but gastric disorders account for the majority of cases. The disease should be treated by attention to the source of irritation when this can be discovered. The chronic form of urticaria is called *cnidosis.* It is to be treated by pilocarpin, and quinine and bromides internally, but in spite of all treatment it sometimes continues for years.

Eyelids, Hordeolum of the. STYE. PERIFOLLICULITIS. See **Hordeolum.**

Eyelids, Horny growths on the. CORNU CUTANEUM. See Vol. V, p. 2534, of this *Encyclopedia.*

Eyelids, Hyaline degeneration of the. Hyalin may occur as a preliminary stage in the development of amyloid, but generally it represents a variety of tissue degeneration distinct from amyloid, and show-

ing no tendency to pass over into the latter. Hyaline and amyloid degenerations present almost precisely the same clinical picture, so that a positive distinction between the two can be made only by examining excised pieces of conjunctiva. Calcification or ossification may take place in the degenerated mucous membrane. The disease attacks people in middle life, and ordinarily both eyes are affected. Such swellings situated in the retrotarsal fold, protrude between the lids and the eyeball; the plica semilunaris also is enlarged until it forms a misshapen mass. These various swellings are so friable that they often tear when an attempt is made simply to separate the lids for examination, although in doing so they bleed very little. The disease runs a very chronic course, dragging on for years without any real inflammatory symptoms, until at length the patient is deprived of the use of his eyes by his inability to open the misshapen lids. Medical treatment is powerless against this disease. We must confine ourselves to removing the growths upon the conjunctiva to such an extent that the lids can be opened and vision thus rendered possible. (Fuchs.)

Morax and Landrieu (*Ann. d'Ocul.*, 147, p. 25) have reported an instance of hyaline degeneration of the submucous tissue of the lids in a subject 60 years of age. Large, irregular, brownish hypertrophies were visible in the conjunctiva of the tarsus and fornix. Histological examination of these when excised confirmed the diagnosis. The bacteriological examination was negative. Ossification was present at the margin of the diseased zone, over which the epithelium was preserved. The connective tissue elements were degenerated, softened and structureless. Hyaline masses, giant and plasma cells, were situated deeply in the tissue. The blood vessels were normal. See, also, **Conjunctiva, Amyloid degeneration of the.**

Eyelids, Hyperemia of margins of the. This is often present in persons who use their eyes excessively for close work, or among those who follow their vocations in a vitiated atmosphere or unfavorable illumination. It is common also in persons with errors of refraction, and in those addicted to the use of alcohol and tobacco. When, in addition to hyperemia, scales or crusts form on the lid margins, it then constitutes one of the various forms of blepharitis. See, also, **Blepharitis.**

Eyelids, Hyperidrosis of the. Excessive sweating of the eyelids occurs in connection with the disease on the face and body. It may be confined to the lids of one eye when there is unilateral facial hyperidrosis. In this case it indicates an irritation or lesion of the sympathetic nerve.

Eyelids, Hyperkeratosis of the. This is a congenital condition and

when the skin of the face is affected, the eyelids may become involved. In mild grades of the disease, when the victim survives, there sometimes results ectropion, loss of eyebrows and eyelashes, conjunctivitis and keratitis, symblepheron, and atrophy of the conjunctiva. Treatment should include alkaline and bran baths to loosen the scales, and the application of lanolin or other unctuous substance. The internal administration of thyroid extract has been recommended.

Eyelids, Impetigo of the. This disease manifests itself as pustules of the size of a split-pea, which disappear spontaneously in a few weeks. There are no subjective symptoms.

Eyelids, Injuries of the. Traumatisms of the lids are commonly met with and are of considerable importance.

Wounds of the eyelids may be punctured, incised, lacerated, or contused. Punctured wounds are of little importance, provided other ocular structures are not injured. They generally heal without scars. It must be remembered that numerous cases are recorded in which foreign bodies, after traversing the lids, have lodged and remained in the orbit without producing acute symptoms. Incised and lacerated wounds call for careful attention. They should be cleansed and accurately approximated with catgut sutures. It is especially important to note whether the canaliculus has been cut or the globe injured. Horizontal cuts do little harm except the suspensory ligament of the upper lid is severed. Vertical and oblique incised wounds, unless seen early and properly sutured, will lead to coloboma, ectropion, entropion, or trichiasis. When the internal palpebral ligament and canaliculi are cut, the function of the lachrymal apparatus will be interfered with. Lacerated wounds, often produced by bursting bottles, meathooks, blows, or thrusts with pieces of wood or a cow's horn, buttonhooks, etc., if treated early will generally give good results. If the canaliculus is torn, the remaining portion should be sought and opened into the sac. It may be possible to unite the two portions by passing a short probe, suturing the lid upon it, and leaving the instrument in place for a few days. Each case of laceration must be judged by itself, and often the ingenuity of the surgeon will be taxed.

Contused wounds of the lids, frequent in persons pugilistically inclined, are followed almost immediately by extravasation of blood into the cellular tissue, producing a condition commonly called "black eye." The blood may be in the form of a diffused ecchymosis or as a hematoma. For prognostic reasons, it is important to distinguish between such an immediate ecchymosis and that which, occurring in fractures of the base of the skull or rupture of orbital vessels, appears later. In such serious injuries, the blood not infrequently is forced

forward into the eyelids. The lower part of the ocular conjunctiva and the lower eyelid (rarely the upper lid also) show hemorrhages. The ordinary "black eye" disappears in two or three weeks. If a fracture has involved the frontal or ethmoidal sinus, emphysema, occurring early, may be associated with a tardy ecchymosis. Edema of the lids is a common result of a blow.

A "black eye" should be bathed with cold water and treated with frequent applications of arnica, lead-water, laudanum or hamamelis. If the blood is present as a hematoma, it will be best to incise the lid and evacuate the clots under aseptic precautions. Abscess of the lid should be treated by incision and the frequent use of a bichlorid solution. Leeches are of no particular value in the treatment of black eye. In sensitive persons the surgeon may conceal the injury by painting the eyelids.

Burns and scalds of the eyelids, if of the first or second degrees, generally heal without deformity. Deeper lesions are frequently followed by cicatricial contraction, displacement of the lid-borders (ectropion), ankyloblepharon, or symblepharon. These conditions will require appropriate surgical treatment. When called to a case of burn or scald, involving the lids, the surgeon should note carefully the condition of the conjunctiva and cornea. The injured area should be treated with gauze soaked in carron-oil, or with lint soaked in a solution of borax or sodium bicarbonate, or painted daily with white lead. Iodoform may be dusted on the surface daily. Large granulating surfaces should be covered with Thiersch's skin-grafts. The principles which guide the surgeon in the treatment of burns and scalds elsewhere in the body will apply to lid injuries. Pain may be so severe as to call for the use of morphin.

Foreign bodies in the eyelids. With the exception of grains of powder, the retention of foreign bodies within the eyelids is of comparatively rare occurrence. Pieces of iron, steel, gun-caps, coal, pencils, splinters of wood, birdshot, dirt, sand, and pebbles are among the substances occasionally found in the lids. Most foreign bodies carry infection with them and produce localized abscesses. In the course of the inflammation the foreign body often is extruded. Metallic bodies, which have been propelled by an explosion, are often sterile and remain imbedded in the lids without causing reaction. Large foreign bodies can be removed through suitable incisions. Small ones can be picked out with a cataract-needle. If the patient is seen shortly after the accident, grains of powder can be removed by scrubbing with a nail-brush. The continued use of gauze soaked in hydrogen peroxid, applied soon after the accident, is said to be

of value. If these measures fail, the surgeon should wait until the acute stage has passed, when the individual grains may be picked out through small incisions or destroyed with the fine point of an electric cautery.—(J. M. B.) See, also, **Injuries of the eye.**

Eyelids, Keloid of the. A connective-tissue neoplasm, frequently the result of a traumatism. It is often seen in the negro. It only rarely attacks the eyelids.

Eyelids, Keratosis follicularis of the. See **Darier's disease.**

Eyelids, Lentigo of the. FRECKLES. Small circumscribed spots or splotches of pigment occur on the eyelids as on other exposed portions of skin. They usually occur in early life, but may be congenital. No treatment is called for.

Eyelids, Lepra of the. See **Eyelids, Leprosy of the.**

Eyelids, Leprosy of the. When the eyelids are involved in this disease process, they present a condition that does not differ from leprosy of the skin in other parts of the body. There is thickening of the skin, and destruction of a part or the whole of the eyelid as a result of the formation of leprous tubercles. The eyebrows and lashes are apt to turn white, or they may drop out, and anesthetic patches of a color paler than the surrounding skin not infrequently develop. Leprosy is distinguished from lupus by the total absence of pain in the former. All treatment for leprosy has proven ineffectual, although chaulmoogra oil is said to be useful. Recently the hypodermic injection of Calmette's antivenene serum has given promise of good results. (Dyer.)

Eyelids, Lipoma of the. Fatty tumors of the eyelids are of infrequent occurrence. They are circumscribed, soft, elastic, and lobulated. Treatment is by excision. See **Tumors of the eye.**

Eyelids, Lippitudo of the. When, in an old case of blepharitis ulcerosa the lid border becomes smooth, red, glazed, everted, thickened, weeping, and destitute of lashes, the term *lippitudo* is applied. See **Blepharitis.**

Eyelids, Lupus erythematosus of the. This affection of the skin which occasionally extends from the face on to the lids, is regarded by most dermatologists as a form of tuberculosis of the skin. It is not easy to diagnose this affection. The disease is characterized by well-defined patches, with reddish, elevated, irregular borders. The centre of the patch is atrophic and slightly sunken, and is covered by light-yellow scales or crusts of sebaceous matter. The patches may coalesce. They may leave pale, superficial cicatrices, or the cicatrix may be bright-red in color. In the treatment of this condition it must be remembered that all procedures, to be successful, must be sufficiently comprehensive to take in the entire affected area. Curetting followed by thorough

cauterization gives good results. The ulcerated surface may be removed by caustic paste. Excision may be practised if the affected area is not too extensive, the loss of tissue being replaced by appropriate transplantation of cutaneous flaps. Multiple scarification with the subsequent application of iodoform may be employed. Exposure to the Röntgen rays is now being tried with some promise of success.

Eyelids, Lupus vulgaris of the. This disease, which is more common in European countries than it is in America, may affect the eyelids when present on the face or nose. It is characterized by the presence of papules, nodules and patches, which either ulcerate or atrophy, leaving scars. It appears almost invariably before puberty, and is more frequent in females than in males. The disease begins as small reddish spots which change into nodules, of a brownish, translucent appearance. After months, or perhaps years, the nodules coalesce and ulceration occurs, which spreads and then cicatrizes spontaneously. Cicatricial ectropion, or entire destruction of the lid, may result, and changes in the eyeball are often found which may even produce complete blindness.

The disease may remain unrecognized for a long time, as the diagnosis is difficult. It should be treated by complete removal of the diseased tissue.—(J. M. B.)

Eyelids, Lymphangioma of the. LYMPHOMA. In consideration of the complicated structure of the lids, in which such a manifold variety of tissue takes part, the most dissimilar kinds of neoplasms at times come under observation in them. Lymphangioma is a rare form of growth, appearing in the form of an elongated, sausage-shaped tumor, elastic and painful. The skin over the mass is often tense, shining, and traversed by dilated veins. Lymphoma develops in the course of leukemia and pseudoleukemia. Optic neuritis, retinitis, and retinal hemorrhages are often present in these diseases. The prognosis is unfavorable. Extirpation of the growths gives only temporary relief. The prolonged internal administration of arsenic has been recommended.

Eyelids, Lymphoma of the. See **Eyelids, Lymphangioma of the.**

Eyelids, Madarosis of the. A condition of the lids in which there is destruction of the cilia, as a sequel to blepharitis ulcerosa. See, also, **Blepharitis.**

Eyelids, Malignant edema of the. See **Eyelids, Gangrene of the.**

Eyelids, Malignant pustule of the. ANTHRAX. See Vol. I, p. 512, of this *Encyclopedia*.

Eyelids, Malignant tumors of the. See Vol. II, p. 1410, of this *Encyclopedia*.

In addition, it may be said here of lymphoma of the lower lid that a case reported by De Lavigerie and Onfray (*Ann. d'Ocul.*, V. 149, p. 281) in a woman of 58 years was part of a general lymphomatosis. The lid tumor was the size of a large almond, and appeared as a firm swelling beneath the external half of the palpebral conjunctiva, which was normal. There were a number of smaller tumors beneath the skin of the face, and in the soft palate. There was a history of multiple tumors, dating back three years, with temporary improvement from time to time. Repeated examination of the blood pointed to a marked and progressive anemia, without leukemia or abnormal leukocytic forms. An excised portion of the lid tumor showed the characteristic structure of lymphoma. The patient died a few months later in cachexia.

Lamb (*Ophthalmoscope*, July, 1913) reports in detail a very interesting case of *perithelioma of the eyelids*. It is described as a type of tumor of the larger group of lymphangio-endothelioma, characterized as exhibiting capillary channels cut in various directions and lined by recognizable endothelium. Around each capillary is a collection of cells many layers deep, arranged radially. The cells are not especially elongated, but the arrangement in rows at right angles to the capillary axis is most characteristic. The probable origin is from the lymphoid endothelium of the perivascular space, thus forming one variety of lymphangio-endothelioma.

The case reported occurred in a mulatto, 50 years of age, with a history of injury to the left eye by a flying wire nail. A tumor half the size of a pea, suspended by a small pedicle and spread out over the sclera, had been dissected off and diagnosed as malignant. The growth recurred, suggesting keloid, and was again removed. When first seen by the writer, the upper and lower lids of the left eye were swollen, especially at the outer canthus, and the lids were pushed forward and away from the eyeball by the growth upon the eyeball itself.

Upon everting the lower lid, a soft, grayish, gelatinous mass, a tesselated homogeneous outgrowth with a suggestion of pseudomembrane, was present, extending from the outer canthus to about the middle of the lower lid, and from the ciliary margin to the fornix, and any attempt to remove it was accompanied by bleeding from the underlying membrane. On everting the upper lid a similar growth, similarly located, but smaller in size, was found, covered by a thick, yellowish, gelatinous exudate, which hung down and bathed the outer portion of the bulb. On the eyeball, half way between the outer canthus and the outside of the limbus, was found a soft, "mushy" tumor, apparently

of subconjunctival origin, about 7 mm. in its horizontal diameter and 5 mm. in the vertical, overlying the external rectus and in nowise limiting motion of the eyeball. The vision, 20/13, was often obscured by superabundant secretion of mucus. Wassermann reaction was negative, as also von Pirquet and Moro tuberculin tests. Removal was followed by recurrence and complete exenteration became necessary. The early removal and the fact that all glands communicating by lymphatic vessels were perfectly normal in size, gave a good prognosis for prolonged life.

Adeno-carcinoma very rarely arises from sweat-glands. Coats, however (*Roy. Lond. Ophth. Hosp. Rep.*, xviii, p. 266), is satisfied that such was the origin of a fleshy growth removed from the upper lid of a woman of 53 years. Near the skin surface on one side of the growth was a collection of glandular tubules, larger and more irregularly disposed than in the case of an ordinary sweat gland, yet imitating its well-known coiled arrangement. The deeper tissue showed a widespread infiltration of epithelial cell masses of a malignant type.

Fleischer's case of papillo-sarcoma of the lid (*Klin. Monatabl. f. Augenhkl.*, May, 1911, p. 689) suggests the importance of microscopic aid in tumor diagnosis. A new-growth of the lower lid in a boy of 10 years presented on the palpebral conjunctiva the appearance of a papilloma. But it extended to deep tissues, and microscopic examination led to a diagnosis of sarcoma and to exenteration of the orbit.

With malignant tumors there occurs an enlargement of the neighboring glands, first in the preauricular gland, afterwards in the glands along the lower jaw and in the neck.

The extirpation of tumors of the lids is conducted according to the well-known rules. In extensive tumors it is often necessary to remove the eyeball, and even the entire contents of the orbit. See, also, **Eyelids, Epithelioma of the,** as well as **Eyelids, Rodent ulcer of the.**

Eyelids, Meibomian cyst of the. See **Chalazion.**

Eyelids, Milium of the. This is a small tumor made up of an agglomeration of the prickle layer of the epidermis which has become snared off into the corium during embryonic life. It is considered by some to be a retention cyst of the sebaceous glands. It is of common occurrence, and is seen generally in the lower lid, but often in the upper one also. It is usually seen about the time of puberty, although it is occasionally congenital. Milia may occur sparsely, or may be thickly studded over the affected area, and the tendency of the distribution is toward the outer canthus. When occurring in patches the disease somewhat resembles xanthoma. The treatment consists of enucleating

every milium with a milium needle, and at the same time destroying the lining membrane of the cyst to prevent recurrence.—(J. M. B.)

Eyelids, Molluscum contagiosum of the. MOLLUSCUM EPITHELIALE. This disease is generally considered to be contagious and autotransferable. It is not of common occurrence, but seen most frequently in children, and the eyelids are frequently attacked. It is characterized by the presence of somewhat translucent warts, the largest being umbilicated. Treatment consists of removal of the sac and its contents. Electrolysis may also be employed, or the application of acid-nitrate-of-mercury ointment. A case of generalized pigmented molluscum fibrosum which involved the lids, was reported by Gabriélidès (*Ann. d'Ocul.*, 147, p. 105). A tumor on the lid had reached the size of a walnut. It was not sharply distinguished from the surrounding connective tissue.—(J. M. B.)

Eyelids, Morphœa of the. MORPHŒA ALBA PLASSA. A trophoneurosis affecting the skin of the lid. It is characterized by the formation of a well-defined, smooth patch, often slightly elevated, and hard to the touch. Later atrophy ensues and the patch becomes slightly sunken (Weeks).

Eyelids, Movements of the. These are accomplished in the following way: In opening the eye the upper lid is raised by the levator palpebræ superioris, the musculus tarsalis superior and the superior rectus. The tendon of the latter is so solidly united with that of the levator by fascial bands that it may be said to have a common insertion with the levator in the tarsus of the upper lid. Hence, when the superior rectus contracts and raises the eye, it assists in lifting the upper lid and the retrotarsal fold at the same time. If the superior rectus retracts from any cause, e. g., as the result of a complete tenotomy producing a traumatic paralysis, the upper lid is pulled up and the eye consequently is wider open than its fellow. On the contrary, in an advancement, in which the tendon of the superior rectus, and with it the fascial bands, are brought forward, the upper lid is carried forward, too, and the eye is 1 or 2 mm. less open than its fellow. The same thing happens in a complete paralysis of the superior rectus, not due to division of its tendon; the relaxed muscle allows the lid to droop somewhat, especially when the eyes are carried up.

The lower lid is carried down not only by its weight, but also by the action of the musculus tarsalis inferior (supplied by the sympathetic) and by a slip which runs from the tendon of the inferior rectus directly to the tarsus. Hence, when the inferior rectus pulls the eye down it depresses the lower lid at the same time, and hence, also, as in the case of the superior rectus, a complete tenotomy of the inferior

rectus makes the palpebral fissure wider, and an advancement of this muscle makes the palpebral fissure narrower. By expansions from their tendons the external and internal recti also act upon the lids, as has been shown by Dwight; so that when the eye is turned outward the outer canthus is pulled outward, and when the eye is turned inward the inner canthus is pulled back and in.

With regard to the shutting of the eyes, we must distinguish between winking and tight closure of the lids. Winking consists in a quick contraction of the palpebral fissure, in which the lids do not come into perfect contact. It can be performed voluntarily, but usually results through reflex action, which is excited by the sense of dryness in the eye, or by the presence of foreign bodies—dust, smoke, etc. It is effected by means of the trigeminus, which is the sensory nerve of the eye and its vicinity, and is hence rightly called the sentinel of the eye.

In firm closure of the lids, which usually is done voluntarily, the edges of the lids are brought into complete contact. This may be done gently, as in sleep, or forcibly as in the act of squeezing the lids together. When the lids become closed in sleep, the eyeball also performs a movement, rolling upward (Bell's phenomenon). This behavior on the part of the eyeball is important, inasmuch as the protection of the cornea by the upper lid is thus provided for, even when the palpebral fissure is not completely closed in sleep. It is not until lagophthalmus reaches quite a high degree that a portion of the cornea remains constantly visible in the palpebral fissure; and this portion is, in fact, always the lowest part of the cornea, which consequently is most exposed to the danger of undergoing desiccation.—(Fuchs.)

Eyelids, Neurofibroma of the. Neuroma of the lids. Plexiform neuroma. Elephantiasis neuromatosa. The lids are very rarely involved in this form of tumor, which is really a fibroma developing from the sheaths of peripheral nerves, there being no new development of nerve-fibres. The growth is either congenital or generally appears in early infancy. The lid becomes greatly enlarged and of elephantiasis-like appearance, and ptosis results. The tumor is soft in general, with localized, cord-like spots which can be traced backward into the orbit. Usually the growth is not painful. Microscopically they are composed of nerve-bundles imbedded in masses of connective tissue. The treatment is excision. If not completely removed, the growth will return. See, also, **Neurofibroma.**

Eyelids, Noma of the. See **Eyelids, Gangrene of the.**

Eyelids, Papilloma of the. Wart of the lids. See **Eyelids, Verruca of the.**

Eyelids, Pemphigus of the. Pemphigus and other bullous affections of the eyelids, such as dermatitis herpetiformis, are occasionally seen. In pemphigus the lesions are large and scattered, while in the latter affection they are small and grouped. Essential shrinking of the conjunctiva sometimes accompanies pemphigus. Relapses are frequent, hence the prognosis should be guarded. The treatment of these conditions is properly in the domain of the dermatologist. See Vol. IV, p. 3050, of this *Encyclopedia.*

Eyelids, Perifolliculitis of the. See **Hordeolum.**

Eyelids, Perithelioma of the. See **Eyelids, Malignant tumors of the.**

Eyelids, Phagedenic ulcer of the. See **Eyelids, Gangrene of the.**

Eyelids, Phlebitis of the. The lids may be involved with neighboring parts in facial phlebitis. The affection is liable to result fatally from extension to the cavernous sinus.

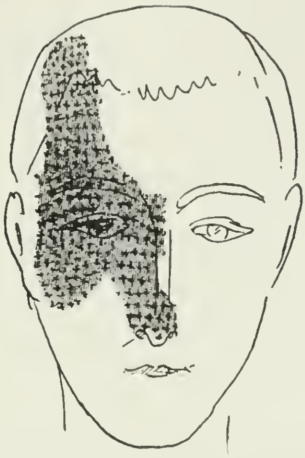
Eyelids, Phlebolith of the. Vein stones are usually found in the optic veins during a search for some other foreign body. Thurston Holland claims they occur so frequently in persons over 40 that in his 600 radiographs it is the exception not to find some of these shadows. Clarke states that, although the exact metamorphosis does not seem to be recorded, phleboliths are defined as having originally been white thrombi in veins which have undergone calcification analogous to that of arterio-sclerosis. Apparently the calcification starts about a central nucleus, forming layer after layer, like the growth of a pearl. Crampton (*Trans. Coll. Phys.*, Phila., Mar. 20, 1913) mentions the usefulness of the X-ray in locating phleboliths. He reports the case of a man, aged 28 years, who had a small network of varicose veins, about 1 cm. in diameter, beneath the skin of the lower eyelid. On palpation a shot-like body was found in a vein and removed through a small incision. The phlebolith, which was white, round, and quite hard, was the size of a No. 6 shot and resembled a lusterless pearl. The patient had been aware of its presence for nine years. There was no history of trauma or syphilis.

Eyelids, Phosphoridrosis of the. Phosphorescent and urinous sweat are seen about the eyelids and always in connection with a generalized form of the diseases, which depend upon an involvement of the entire system.

Eyelids, Pigmentation of the. A brown pigmentation of the lids has been observed by Jellinck as an early symptom of Graves' disease.

Poulard and Canque (*Bulletins de la Soc. d'Opht. de Paris*, April, 1908) also report the case of a soldier, who received a blow in the eye, causing impaired vision, loss of the upper part of the field and vision equal 1/10, although the ophthalmoscopic appearances were normal.

A few weeks later the lids showed discoloration, which involved the eyeball and extended to the area shown in the figure herewith. After two years, the skin was slate-color, the eyeball blackish, and the iris more deeply colored than its fellow.



Pigmentation of Eye and Adjoining Parts.
The shaded area shows the part affected. (Poulard and Canque.)

Eyelids, Poliosis of the. The absence of pigment in the cilia. See Vol. II, p. 1382, of this *Encyclopedia;* as well as **Eyelids, Bleaching of the.**

Eyelids, Reconstruction of the. Although this subject is discussed on p. 1084 *(et seq.)*, Vol. II, of this *Encyclopedia*, to which the reader is referred, it may be added here that, recently, Carruccio (*La Clinica Oculistica*, p. 1604, 1914) has reported a successful case operated on by the method of Cirincione. The writer says that as regards the extensive use of the skin of the ear, together with cartilage for replacement of the tarsus, the traumatism produced by the growth of hair in contact with the cornea is a serious objection. The method described by Cirincione in the *Clinica Oculistica* for 1901 satisfies all the requirements of such a case, using for the new conjunctival surface the normal conjunctiva, and for the skin layer a pedunculated cutaneous flap. Yet, says Carruccio, the fairly recent *Encyclopédie Française d'Ophtalmologie* does not mention any process which may be used to reconstruct a lid which has been entirely lost.

Carruccio describes the method as applied to the case of a woman of 71 years, the whole of whose lower lid was removed on account of extensive epithelioma. The residual conjunctiva of the lower fornix was loosened so as to form a narrow flap about 0.5 cm. wide. By an

intramarginal incision the upper lid was divided in its whole length into two layers, a musculo-cutaneous and a tarso-conjunctival. After passing the adherent upper margin of the tarsus, the outer layer was drawn up by an assistant, while the inner layer was drawn down and the separation of the conjunctiva extended as far as the upper fornix. The tarso-conjunctival layer thus dissected was easily stretched downward so as to reach the narrow flap formed from the conjunctiva of the lower fornix, to which it was sutured with catgut.

In this particular instance the inability of the patient to endure a more lengthy operation at one sitting caused postponement of the remaining steps until two days later. On this second occasion the external surface of the conjunctival layer was freshened by curettement, and a pedunculated flap from the temple was utilized to form the outer layer of the new lower lid, interrupted sutures being inserted along the skin margin at the inner and lower sides of the dehiscence and along the free border of the musculo-cutaneous layer of the upper lid, avoiding the eyelashes.

At the end of 24 days the lids were found distended with lachrymal fluid, which was evacuated through a small incision at the inner canthus. At the end of a month from the original operation the palpebral aperture was re-established by the surgeon, the conjunctival and skin margins of the new lower lid being approximated with a few sutures to hasten their union. It was necessary at the same time to remove an exuberant cutaneous fold corresponding to the peduncle of the skin flap. In time the new lid assumed a normal position, applying itself accurately to the eyeball. Equally good results were obtained in cases operated upon with the same technique by Cirincione and Calderaro (*Ophthalmic Literature,* Feb., 1915).

Eyelid retractor. See **Lid retractor.**

Eyelids, Rhagades of the. See **Eyelids, Fissures of the.**

Eyelids, Rodent ulcer of the. JACOB'S ULCER. CANCROID ULCER. See **Eyelids, Malignant tumors of the**; as well as Vol. II, p. 1381, of this *Encyclopedia.*

Eyelids, Rubeola of the. See **Measles.**

Eyelids, Sarcoma of the. Primary sarcoma of the eyelid is of rare occurrence. It develops from the connective tissue of the lid, appearing at first as a rounded, usually slightly reddened, elevation of the lid, somewhat resembling a chalazion, although the position is not always over the tarsus and the skin is not freely movable over it. The growth is usually slow, but it may advance rapidly to a fatal result, other parts being affected by metastasis. The cause is obscure. In a small percentage of cases traumatism has been followed by sarcoma.

Histologically the growth is composed of round or spindle cells, or both. Pigment may be present in the cells or stroma (melano-sarcoma). Sarcoma is to be differentiated from lymphoma, syphilitic tubercle and gumma. In the last two named, spirochæta pallida may be found.

Treatment of sarcoma demands early excision in order to afford any chance of recovery. Recurrences are extremely common, even after early operation. If the growth is very small, the use of radium may be successful in arresting the disease. Roentgen rays are of no service. In cases where a sufficiently clear diagnosis has not been made with the microscope, antisyphilitic treatment should be employed sufficiently long to decide the true character of the growth.

A case of sarcoma of the lids was reported by Alling (*Ophth. Record*, June, 1907) in a child of 7 years, who during six weeks' time developed a hard tumor the size of a pea underneath the skin, a little below and outward from the left outer canthus, with three or four smaller ones lying on the tarsal plate of the lower lid and one over the outer part of the tarsus of the upper lid. There was no glandular involvement. During two weeks the growths had increased in size decidedly. They were removed through a skin incision which exposed all of them. The wound healed kindly, but two months later there was evidence of recurrence. They were now known to be malignant, and a month later a more radical operation was done, but the child died shortly after from scarlet fever. The report of the pathologist was that the growths were fibro-myxo-sarcoma.

Two cases of *melanosarcoma of the lids* are reported by Montano (*Anales de Oftalmologia*, May, 1913). The first patient was a man of 26 years. A small, ulcerated, black growth had been removed by an oculist twelve months after its first appearance as a black spot at the internal angle of the left eye. The growth recurred four months later, was again extirpated, and again reappeared after another three months, this time infiltrating the two lids. At this time there was a large swelling of the lids on the left side. Diagnosis of melanosarcoma originating in the lachrymal caruncle was made; and the lids were entirely removed, together with the eyeball. There had been no recurrence in the short period of two months elapsing since the operation. In the second patient, a woman of 40 years, a small, blackish tumor had appeared in the lower lid of the right eye four years previously, and had been removed, with the exception of a small crescentic area which had remained stationary for three years. Recent growth had been so rapid that closure of the lids was impossible.

In the *treatment* of sarcoma of the lids, the X-ray and radium has been used, but because of the tendency to return rapidly, excision of the tumor should be prompt and radical. See, also, **Eyelids, Malignant tumors of the**; as well as **Tumors of the eye.**

Eyelids, Scalds of the. See **Eyelids, Injuries of the.**

Eyelids, Seborrhea of the. The dry form of seborrhea is seen occasionally on the upper lid, and the oily form on both lids. Local applications of sulphur ointment, or of equal parts of sulphur and a 5 per cent. oleate of mercury ointment, give good results. Appropriate internal treatment is also indicated.

Eyelids, Serpiginous syphilide of the. This may closely resemble lupus or tuberculosis, and produces extensive destruction unless checked by appropriate internal treatment.

Eyelids, Siderosis of the. Discoloration of the lids, caused by the penetration of the skin by small pieces of steel. It shows itself as small brown spots.

Eyelids, Solid edema of the. This term is applied to a swelling of the eyelids, generally the lower lid, which is often so great as to conceal the interpalpebral fissure. The swelling is soft and elastic, of a reddish-brown color, without evidences of inflammation or involvement of other tissues, and pits on pressure. The disease in most cases has followed an attack of erysipelas. Some of the cases have terminated in tuberculosis of the conjunctiva. It is supposed to be a recurrent lymphangitis, but the nature of the disease is obscure. No permanent benefit has followed any of the methods of treatment.

It is also used as a synonym of elephantiasis. See Vol. VI, p. 4279, of this *Encyclopedia.*

Eyelids, Sporotrichosis of the. See the major heading **Sporotrichosis.**

Eyelids, Steatoma of the. This appears as a smooth round tumor varying in size from a pin-head to that of a hazelnut. It is supposed to belong to the class of dermoids. It is situated usually near the outer canthus on either the upper or lower lid. The growth is caused by some injury to the opening of the sebaceous gland. It grows slowly. The cyst contains broken-down epithelial cells, forming a pultaceous mass. There are well-defined walls to the tumor. They occur at any period of life. The treatment consists in emptying the tumor of its contents and destroying the lining sac.

Eyelids, Sudamina of the. These small vesicles which are seen most frequently on the hands, are also rarely observed on the eyelids. The condition is caused by a too rapid formation of sweat, and occurs most frequently in summer. It disappears rapidly under the influence of a 1 per cent. solution of chromic acid, applied twice daily.

Eyelids, Syphilis of the. Primary, secondary, or tertiary lesions of syphilis may be present in the eyelids, or the disease may occur there as an hereditary manifestation. Chancre may appear at any period of life, and until the development of secondary symptoms the diagnosis may be in doubt. It shows as an ulcer with an indurated base; the pre-auricular gland is always, and the submaxillary is frequently, indurated. The condition might be confounded with the pustules of vaccinia, or with tuberculous ulcer.

In a case reported by Shoemaker (*Ann. of Ophth.*, XX, p. 544) of a woman aged 30, the first symptoms were swelling of glands in front of the right ear and beneath the lower jaw on the same side, followed by slight irritation at the inner corner of the right eye. The appearances were almost exactly those of a hordeolum, but in a few days a ring or wall of marked induration, with more or less glazed or indolent-looking central areas, made the clinical diagnosis of chancre easy. The lesion subsequently spread somewhat and came to involve both lids. Examination showed spirochætes. Rollet and Genet (*Ann. of Ophth.*, XXI, p. 571) observed two chancres of the face in the same subject, one upon the lower eyelid and the other upon the chin. The conjunctiva and mucous membrane of the mouth were unaffected. Crigler (*Arch. of Ophth.*, XI, p. 281) obtained cicatrization of rupial syphilis of the eyelid which had developed during mercurial treatment, from three or four injections of cacodylate of soda; in about one month the Wassermann reaction was negative. Fisher (*Ophth. Soc., Unit. King.*, XXXI, p. 268) reports a case of gummatous tarsitis with loss of substance from ulceration of the lid margin.

Chancre is found more frequently on the lower than on the upper lid, and in men more frequently than in women. The infection may be carried by unclean fingers, towels, instruments, by kissing, or in attempting to remove foreign bodies by licking. In a small town in Russia 34 cases of chancre of the eyelids were known to have been caused by a female quack who treated granular conjunctivitis by everting the lids and licking them.

Marbiax's patient (*Soc. Belge d'Opht.*, V. 34, p. 86) apparently received his primary luetic infection through dressing a burn at his internal commissure with pig omentum furnished him by a syphilitic butcher. The use of salvarsan was followed by a neurorecidive affecting the auditory nerve. In Bielsky's case (*Arch. d'Ophth.*, V. 33, p. 126) the infection was introduced by the bite of an adversary on the upper lid.

See, also, Vol. III, p. 2003, of this *Encyclopedia;* as well as **Eyelids, Gumma of the.**

Physicians, while treating the throats of syphilitics, have become inoculated by the patient's saliva projected by coughing. The prognosis is favorable under the appropriate treatment by the local application of the yellow wash, and the administration of mercury internally or by innunction.

Eyelids, Syphilitic ulcer of the. This, as a secondary lesion, is most frequently located in the skin near the lid margin or below the inner canthus. It may result from the breaking down of a tubercle of the skin, or of a gumma originating in the skin, or more frequently in the subcutaneous tissue and cartilage. It is a late manifestation, and, though usually classified as secondary, might perhaps more correctly be placed among the tertiary lesions. This ulcer is sometimes first seen long after other syphilitic symptoms have subsided, thus making the diagnosis more difficult. It may be mistaken for lupus or epithelioma, from which it is sometimes difficult to distinguish it. When situated over the lachrymal sac it may be taken for dacryocystitis (Mackenzie). It is important to make a prompt diagnosis, as while the syphilitic ulcer usually yields promptly to constitutional treatment, caustics are useless, and the knife is dangerous (Harlan). See **Syphilis.**

Eyelids, Tarsal tumor of the. See **Chalazion.**

Eyelids, Tattooing of the. See **Eyelids, Gunpowder grains in the.**

Eyelids, Telangiectasis of the. See **Eyelids, Angioma of the.**

Eyelids, Tuberculosis of the. True tuberculosis of the lid skin is a rare disease. It shows itself in the form of discrete, shallow, painless ulcers with eroded, irregular edges. The ulcers never heal; when the crusts are removed, a reddish-yellow granular surface is exposed. The ulcers spread continuously, and coalesce with other ulcers to form large areas. The disease is found most frequently in regions where skin and mucous membrane join. Since tubercle bacilli are found in *lupus vulgaris, scrofuloderma,* tuberculous ulceration, and *tuberculosis verrucosa cutis,* the term tuberculosis of the skin is loosely applied to affections which, however similar they may be microscopically and pathologically, present marked clinical differences (Crocker). The prognosis of tuberculosis of the skin is unfavorable.—(J. M. B.)

Boer (Graefe's *Arch. f. Ophth.,* V. 85, p. 273, 1913; review in the *Ophthalmic Year Book*) relates a number of case histories to illustrate the frequency with which a diagnosis of ocular tuberculosis may depend upon the clinical appearance, together with the general condition of the patient, although the tubercle bacillus may not be demonstrated in the local lesion, and animal inoculation may prove negative. One case was that of a 21-months-old child, who during a severe con-

junctivitis developed a thickening of the upper lid, which increased after recovery from the conjunctivitis. The condition was unilateral, ran a chronic course and was accompanied by marked thickening of the tarsus. The von Pirquet test was positive, and microscopic examination of excised tarsal tissue showed typical tubercles.

Under the title of primary tuberculous lupus, Morax and Landrieu (*Ann. d'Ocul.*, V. 150, p. 266, 1913) describe a non-ulcerative affection which had existed for one year in both lids of a man of 20 years. The lesions consisted in a thickening of the skin of the lid margin and of the neighboring parts. There was some crusting of the most prominent parts of the swelling, but no actual ulceration. Some of the Meibomian glands looked like chalazia of moderate size. Histologically the infiltration involved the skin and the Meibomian glands. The tuberculous character of the lesions was clearly proved by animal inoculation. Free excision of the affected parts resulted in cure.

Of the two cases reported by Friedenwald (*Am. Jour. Ophth.*, v. 30, p. 65, 1913), one was that of a man of 60 years who had an inflammation involving the inner half of the right lower lid, which looked a good deal like an inflamed chalazion. An excised fragment showed numerous tubercles. Slow recovery followed Roentgen ray applications. The patient's health was otherwise normal. The second patient was a girl of 13 years, who had an inflamed and swollen area around the inner canthus of the left eye. An excised portion of the skin surface showed tubercles. See, also, **Conjunctiva, Tuberculosis of the**; as well as **Tuberculosis of the eye**; also **Phlyctenular conjunctivitis.**

Eyelids, Tumors of the. Tumors of the lids seated in the cellular tissues, such as dermoid and sebaceous cysts, etc., may be easily removed by ordinary surgical methods, the incision being made, when possible, parallel to the fibers of the orbicularis.

Small tumors, as papillomata, adenomata, etc., seated on the border of the lid, may frequently be excised without destroying the lid border, if the posterior margin is not involved. The lid margin is split behind the growth, and a V-shaped piece of the skin, including the small growth, is then excised, the lips of the wound being united by fine sutures.

If the growth is larger and involves the tarsus, it may be necessary to remove a wedge-shaped piece from the whole lid, after which the defect must be immediately closed with sutures after the manner described under **Blepharoplasty.**

Large tumors, that involve a considerable part of the skin of the lids, must be removed according to surgical rules for such conditions,

and the defect closed by an appropriate plastic operation.—(W. H. W.) See, also, **Tumors of the eye.**

Alt (*Am. Jour. Ophth.*, V. 29, p. 363, 1913) describes an unusually large cyst in the lower eyelid of a boy of 9 years. The cyst, development of which had been noticed for a year, involved a little more than the inner half of the lid, reaching about 4 mm. above the lid margin, and partly covering the pupil. The Meibomian glands were represented by delicate lines on the cyst wall. The growth was dealt with by incision and packing.

The myoma of the orbicularis recorded by Schnaudigel (Graefe's *Arch. f. Ophth.*, 74, p. 372, 1913) in 1910, recurred 18 months after removal. The secondary growth reached a size of 20 x 17 x 7 mm. Its general characteristics corresponded precisely with those of the original growth, of which it is assumed that a small portion must have been overlooked at the first operation.

Angioma, angiofibroma and lymphangioma may also be removed by excision, provided this can be done without too much loss of the skin surface. If the tumor is beneath the skin and does not involve it, an incision may be made down to the tumor, which can then be dissected out. The lid clamp will be useful in such cases (*Archiv. f. Augen. u. Ohrenh.*, VI, p. 38).

If the tumor is too extensive for excision, one may have recourse to electro-puncture or electrolysis. The positive pole of a galvanic battery, with a sponge or plate electrode, is placed on the face. The negative pole is attached to a needle mounted in a suitable handle. When the needle is plunged into the tumor, the current is turned on, and electrolysis is indicated by the appearance of bubbles of hydrogen gas at the point of puncture. The needle is then withdrawn and inserted at a different place, and a number of punctures are made at the same sitting. Several such treatments will be necessary, and care must be taken that the punctures are not too numerous, nor too near together, to avoid extensive necrosis. The electrolytic action causes coagulation of the blood in the vessels of the growth, and their eventual obliteration.

Eyelids, Tylosis of the. A frequent sequel of blepharitis marginalis, in which the lid-margin becomes hypertrophied and rounded, and bordered with fleshy-looking conjunctiva. See **Blepharitis.**

Eyelids, Ulcer of the. Ulcers on the skin of the eyelids may be produced as the result of injuries, burns, caustics, scrofula, lupus, and syphilitic ulcers. In children scrofulous ulcers are often found in conjunction with caries of the adjacent bone. Lupus is likewise of frequent occurrence in the lids, usually migrating to them from the nose or cheek. The syphilitic ulcers of the lids are either examples

of initial sclerosis or degenerating gummata. Soft chancre also occurs on the lids. Vaccine ulcers occasionally develop on the lids, generally in children, through carelessness, as a result of the transference of some of the secretion from vaccine pustules from some other part of the body. They form large, very coated ulcers, situated on the edges of the lids, and even of the conjunctiva. The preauricular lymphatic gland is swollen, and sometimes fever is present (Fuchs).

Eyelids, Uridrosis of the. Urinous sweat is occasionally seen about the eyelids, always in connection with some systemic form of the disease.

Eyelids, Urticaria of the. See **Eyelids, Hives of the.**

Eyelids, Vaccinal eruption on the. See **Eyelids, Ulcer of the.**

Eyelids, Varicella of the. Chicken-pox of the lids. This affection occurs infrequently, and when found is of little importance, often but a single lesion being present. There are practically no subjective symptoms until a crust forms, when there will usually be a slight itching. If the crust is removed a rather marked and deep pit will be left. It requires no special treatment.

Eyelids, Varicose veins of the. Dilated and tortuous veins are occasionally seen, especially in the upper lid.

Eyelids, Variola of the. Small-pox of the lids. The eruption of small-pox manifests itself on the eyelids in the papular, vesicular, and pustular stages. The integument becomes swollen and edematous, and of a bright-red color. More or less conjunctivitis is present with some muco-purulent discharge. There is burning and itching of the lids which can be relieved by the use of red rays, which will also tend to prevent pitting. Antiseptic instillations should be used to prevent as far as possible the further development of pus. Although not usually severe on the lids, the eruption at times becomes confluent. See **Small-pox**; as well as Vol. III, p. 2056, of this *Encyclopedia.*

Eyelids, Verruca of the. Wart. Palpebral papilloma. The most common form of wart occurring on the lids is the so-called filiform variety, and is found chiefly in old persons. These growths should be removed by acids, caustics, electrolysis, or by surgical means.

Eyelids, Vitiligo of the. This term is usually employed to denote an acquired achromatism of the skin, as distinguished from *albinism*, which is a congenital condition. Because of a deficiency of the pigment, the skin presents patches of a milky-white color. There appears to be no efficient treatment for this condition.

Eyelids, Warts on the. See **Eyelids, Verruca of the.**

Eyelids, Wounds of the. See **Eyelids, Injuries of the.**

Eyelids, Xanthelasma of the. See **Eyelids, Xanthoma of the.**

Eyelids, Xanthoma of the. The *plane* variety of xanthoma is of not infrequent occurrence in the skin of the eyelids. It appears as oval or crescentic patches of a straw or sulphur-yellow color, varying in size from a pin-head to the thumb nail. The lesions present the appearance of a piece of chamois set into the skin. The macules occasionally become confluent. Their most common situation is on the upper lid near the inner canthus. The *tubercular* form of xanthoma rarely occurs on the eyelids. There is an abundance of cholesterin crystals, and a number of new cells known as xanthoma bodies. The condition is accompanied by a fatty degeneration, which in this situation affects the fibres of the orbicularis palpebrarum muscle. Treatment by the X-rays and electrolysis are recommended, and have been followed by good results in a few instances.

Schindler (*Zeit. f. Augenh.*, 25, p. 62) effected a cure by three exposures to radium.—(J. M. B.)

The Editor has had many satisfactory cures, with little scarring, after a single application of a one per cent. mixture or solution of mercuric chloride, the eschar falling off in from ten to fifteen days, leaving a smooth surface.

The pathological aspects of this condition are well presented in a case reported by van Lint and Steinhaus (*Ann. d'Oculist.*, Vol. 148, July, 1912). The patient was a woman, 50 years of age, who had a tumor in each temporal region. All her lids were completely covered with typical, slightly raised, xanthelasma. They had become so two years before—after three years slow steady growth from a spot near left inner canthus—at which time a lump appeared just behind the right outer orbital margin, to be quickly succeeded by one on the left side. The right tumor was now the size of a pigeon's egg, mobile under the skin, firm and cartilaginous in consistence, painless, without fluctuation, covered by normal skin without vascular or pigmentary change. The left tumor was similar but only the size of a nut. No xanthelasma anywhere else. She was fully examined medically but nothing abnormal was made out about the liver, no icterus; no diabetes. Previous history good, and family history showed that neither her father nor mother, who died respectively at 76 and 79, nor her two brothers nor sister had any xanthoma. The tumor was found to be localized but not encapsuled, hard like a fibroma and not at all like a lipoma, and of the typical chamois-leather color. It was free from the skin but on its inner aspect yellow tracks were seen continuous with the deeper layers of the lid skin, while on the external side it seemed continuous with a layer of tissue over the temporal aponeurosis, but the limits of extension in this direction were not determined.

Steinhaus says that till 1908 the contents were considered to be fat that had infiltrated the cells of a new formation variously described as fibroma, sarcoma and endothelioma. The yellow pigment grains found in the cells relatively free of this infiltrated fat are lipochrome. A connection between diabetes and liver diseases with icterus on the one hand and xanthoma on the other can be established in 50 per cent. of cases, in the rest family disposition seems the only explanation. But in 1908 Pincus and Pick, of Berlin, found that the substance, till then considered as common fat, was really anisotropic, i. e., doubly refracting by the polariscope, and that the staining of it with Sudan iii an unstable gray coloration with osmic acid showed it to be nearly related to fat, probably a lipoid. (Just as fat is a glycerin + a fatty acid, so is lipoid cholesterin + a fatty acid.) Twenty-five years before Touton had found crystals of cholesterin in xanthoma, although none are to be found in normal skin. Pick suggested that this cholesterin might be the product of decomposition of an ester of cholesterin and of a fatty acid, and this supposition has been substantiated fully by chemical analyses by Pringsheim, of Berlin. In the blood of diabetic and icteric patients the presence of an ester of cholesterin and of fatty acids has been proved, and Pick jumped to the conclusion that in such patients with xanthomata there was a deposit from the blood of these lipoids, while in the idiopathic cases he postulated true neoplasms with xanthomatous characters. Steinhaus is not satisfied that there is ground for supposing the existence of both xanthomatous infiltrations and neoplasms.

Steinhaus found the mass to consist in great part of a new-formed fibrous tissue cells with fibres regularly disposed in bundles, the protoplasm in places being voluminous, with an oval nucleus and drops of lipoid. The lipoid cells form quite a thick wall round the vessels. Over large areas there may be few fibres but many cells. These cells are mostly mononuclear but bi- and poly-nuclear ones are seen, mostly around the vessels.

When the lipoid substance has been extracted from the tissue there remains quite a lot of tissue which Steinhaus thinks must be considered as new-formed and not merely the normal tissues that have been infiltrated. This tissue may be neoplastic, hyperplastic or inflammatory, but Steinhaus sums up in favor of neoplastic proliferation. He points out that the cells stain deeply and have plenty of protoplasm, with a fine chromatic network, a central nucleolus and a relatively large number of mitotic figures. As the cells become gorged with lipoid these details disappear and even the pigment goes. The corium may have its thickness doubled or even more than trebled. Small lymphocytes

and plasma cells may be found. The hypothesis of a simple lipoid infiltration of the normal cellular elements of the corium is in absolute conflict with the facts. The cells found in inflammations and infectious granulomata are the neutrophile leucocytes, the lymphocytes and their derivatives the plasma cells, but the lipoid cells do not resemble these at all.

An analogy has been drawn, especially by Borst, between xanthomata and nevi.

Usually the xanthoma does not have a limitless proliferation and may arrest itself after a time and remain stationary or even recede as when the lipoid cells necrose. Steinhaus thinks the formation of lipoid within the cells is the most plausible view, like the production of glycogen in some endotheliomata. Although in many cases of xanthoma there seems to be a connection with diabetes or icterus, there are very many such patients who never get xanthoma and it may be that some germ is at work. (W. C. Souter, review of the *Ophthalmic Review*, p. 84, March, 1913.)

Eyelids, Yaws of the. See **Eyelids, Frambesia of the.**

Eyelid, Third. PLICA SEMILUNARIS. See **Comparative ophthalmology,** Vol. IV, p. 2682, of this *Encyclopedia.*

Eye Lotion. EYE WASH. EYE WATER. See **Collyrium.**

Eye, Methods of examining the. See **Examination of the eye.**

Eye-needle of Mooij. This instrument is, as the illustration shows, a mounted needle for the same use in ophthalmic surgery as the cor-

Mooij's Eye Needle.

responding device in general surgery. It may, however, also be employed for introducing sutures, setons, etc., into and around the ocular muscles and into the eyeball itself.

Eye, Normal. The question, what constitutes a *normal* eye?, has been variously answered by different authorities. The Editor agrees, however, with the dicta of Charles Oliver (*System of Diseases of the Eye,*

Vol. IV, p. 402) that by this term is not meant the findings of the mathematical formulæ of the arithmetician, which give ratios of supposed dioptric perfectness that are used to specify the emmetropic organ. The "normal eye" is not designated by the dividing line between the convex and the concave correcting lenses that has been assigned as the expression of an emmetropic ideal by the working clinician. Neither is the "normal eye" the result of the solution of the geometric and triginometric problems that offer some optical theorists the assumption of the condition of absolute sphericity.

Just as with any other eye, the existence of such a normal eye is dependent on the freedom of the structures from disease, in association with an undisturbing physiologic action giving as near a normal visual result for both near and far as possible. Provided that these conditions be present, it is of no consequence what the shape or what the size of the organ may be. If it be healthy and if it be acting properly, it is normal.

Eye of Pascal, The. The cognizance of Blaise Pascal. It consisted of an eye surrounded by a crown of thorns and these words: "*Scio cui credidi.*"

The story of this cognizance is, in brief, as follows: A little niece of Pascal, who had an incurable "ulcer in the lachrymal gland," etc., and who was one of the pupils in the Port Royal School at Paris, was being nursed and otherwise cared for by the nuns connected with that institution. Now, in this school there happened to be a certain reliquary, which contained one of the thorns from the Saviour's crown. The affected eye, having been touched with this reliquary, became at once and completely cured. Thereupon Pascal adopted as his cognizance the above-described device.—(T. H. S.)

Eye, Parietal. Median eye. This organ, seen in some reptiles, amphibians and fishes, is a more or less well developed vestige derived ancestrally from the extension forward and upward into a median-dorsal position of the head. See **Comparative ophthalmology**; as well as **Evolution of the eye.**

Eye phantom. A mask used for teaching, or learning to do, operations on the eye. See **Phantom face.**

Eye-piece. A combination of two lenses used to supplant the single eye-lens to which the eye is applied in viewing the image produced within the tube by the objective of a telescope or microscope. It consists of the eye-lens and the field-lens that is interposed between the former and the objective for the purpose of enlarging the field of view. The relative power of the lenses and their distance apart depend upon the requirements sought to be attained. *Huyghens' eye-*

piece is designed to diminish the effects of spherical aberration as much as possible; wherefore, the focal lengths and the positions of the field and eye lenses are so chosen that each lens shall produce an equal increment of deviation in a ray initially parallel to the axis. In this eye-piece, which is known as a *negative eye-piece,* the focal lengths of the field and eye lenses are in the ratio 3:1, while the distance between them is numerically equal to twice the focal length of the eye-lens. The Huyghenian eye-piece is especially adapted to the microscope. *Ramsden's eye-piece* is designed to observe the coincidence of a point of the image with the intersection of cross-hairs, or to measure the dimensions of the image by the aid of a scale in the eye-piece. It consists of two plano-convex lenses, of equal focal lengths, whose convex surfaces face each other and are separated by a distance equal to two-thirds of the numerical value of the focal length of either lens. This eye-piece is termed a *positive eye-piece. Reflecting eye-pieces* comprise the *diagonal* or *prismatic eye-piece,* which deflects the emergent rays at right-angles to the axis of incident rays, and the *collimating eye-piece* used to determine the error of collimation in a transit instrument. *Terrestrial* or *erecting eye-piece* presents the object erect instead of inverted.—(C. F. P.)

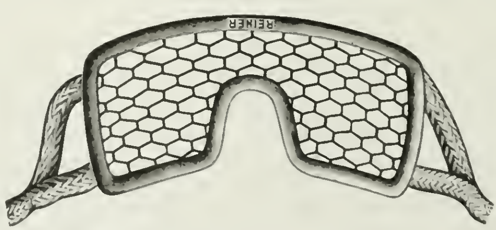
Eye-piece indicator. A printing device used in connection with an eyepiece for marking any object in the field of view.

Eye-piece micrometer. An eyepiece connected with a micrometer for the purpose of measuring the size of the real image of an object.

Eye, Pineal. EPIPHYSEAL EYE. The rudimentary median eye in some lizards and other animals. See **Evolution of the eye**; as well as **Comparative ophthalmology.**

Eye-point. An eye-spot; an ocellus. Also, the bright circle at the crossing point, or nearest approximation of the rays above the ocular of a microscope. It is best seen with a strong illumination for the microscope, and a piece of ground glass or thin paper above the ocular for a screen.

Eye-protector. A name variously applied to eye-shades, masks, shields,



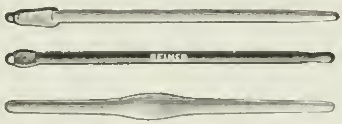
Eye Protector, for Both Eyes.

tinted glasses, goggles, etc., for protecting the eyes from traumatisms, light, dust, wind and infective material.

A shield for protection against accidents after operations is shown in the accompanying cut, and the whole subject is fully discussed on pages 156 *et seq.* in Vol. I of this *Encyclopedia.*

Eye, Reduced. See **Physiological optics.**

Eye rods. These are simply hard rubber or glass rods provided with

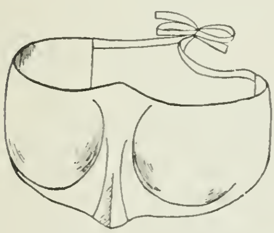


Eye-Salve Rods of Fuchs and Reuss.

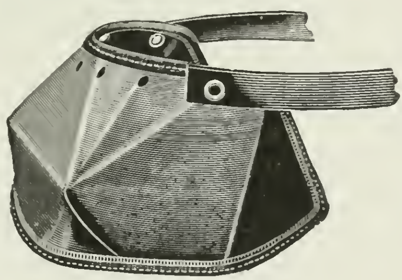
pointed, flat or bulbous ends and used for applying ointments and solutions to the eye. See the cut.

Eye, Schematic. See **Physiological optics.**

Eye shade. This form of protection has been and will be described

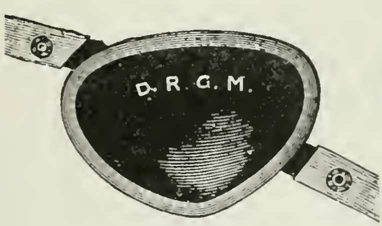


Ring's Ocular Mask.

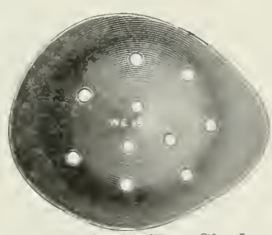


Panama Eye Shade.

further in this *Encyclopedia* under various captions, such as **Eye masks; Eye-protector,** as well as under headings such as **Cataract,**



Oppenheim's Eye-Shield.



"Cartella" Eye Shade.

that involve a reference to or description of them. Here it may suffice to say of them that eye shades are sold in a variety of shapes, colors and sizes. The *Extra Pharmacopeia* divides them into the following

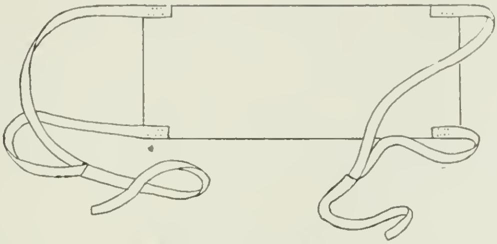
classes (Great Britain): 1. Card covered with silk, flat or concave, suitable for either eye. 2. Celluloid, flesh-color, for right or left eye, or suitable for either eye. 3. Of pith, the "symétrique." 4. Straw, plaited, in three sizes. 5. Double eye shades, card, pith and celluloid.

Buller's Shield.

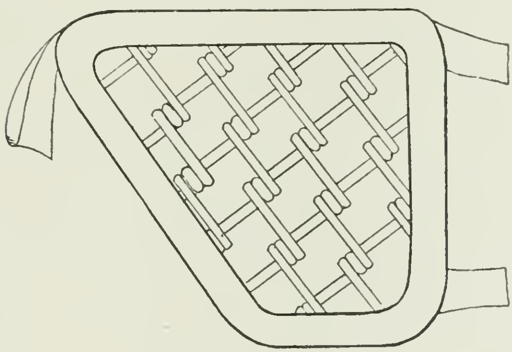
"Triangular" Bandage.

In addition to the forms already pictured the so-called Panama eye shade protects the eye in all directions and may be worn by automobilists as a dust shield. It is made of opaque, translucent and transparent celluloid and also of leather. It has adjustable head straps without prongs to tangle the hair.

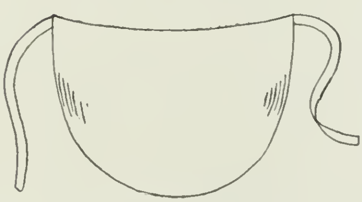
The Cartella is a trade name for a useful eye-shade, made of cardboard, pierced with ventilating holes, and adaptable to the margin of the orbit. It can be employed as an ordinary protector or arranged to hold dressings in place after operations on the eye. See, also, p. 156, Vol. I, of this *Encyclopedia.*



Moorfields Bandage.



Fuchs' Wire Mask.



Ordinary Eye Shield.

Eyesight, Preservation of. See **Blindness, Prevention of,** p. 1138, Vol. II; as well as **Conservation of vision,** p. 2136, Vol. IV, of this *Encyclopedia.*

Eyes, Multiple. See **Comparative ophthalmology.**

Eyes of birds. See **Birds, Eyes of,** p. 979, Vol. II, of this *Encyclopedia;* also **Comparative ophthalmology.**

Eyes of soldiers, sailors, railway and other employees, Examination of the. This section will be considered under the following captions, and in the following order: 1. Necessity for examination. 2 and 3. Definition and description. (a) Army; (b) Navy; (c) Railway. 4. Visibility of signals. (a) Navy; (b) Railway. 5. Factors interfering with visibility of signals. 6. Rules and regulations governing examination of vision in the army, naval and railway and street railway services. 7. Tests for visual acuity. 8. Edridge-Green's theory of vision and color vision. 9. Tests for color vision not already described in this *Encyclopedia.* 10. Value of office tests. 11. Adequacy of color vision tests. 12. Advantages and disadvantages of glasses. 13. Protection of the eyes.

The amount of ametropia, manifest and latent, regularly found upon examination of the eyes of apparently otherwise healthy individuals is astounding. Considered in conjunction with the congenital defect of the visual apparatus known as color-blindness it is certainly a sufficient argument as to the necessity of a rigid examination of the eyes of men engaged in professions or occupations in which the determination of shape, position, movement and color is used as a means of information or communication. Under this heading fall members of the army, naval and marine services, pilots, employees of steam and electric railways, other corporation employees and those in charge of motor-driven vehicles.

NECESSITY OF EXAMINATION. DESCRIPTION OF SIGNALS.

Signals are conventional or intelligible signs designed for information, guidance or a means of communication. Those in which shape, position, motion or color is used for such purpose are made manifest to the individual through the medium of the visual apparatus.

Signaling in the army has not developed to the extent it has in navy and railway signal work, other means of communication, such as the telegraph and telephone, being as a rule easily accessible and a part of the signal corps equipment. Those chiefly used by day are motion signals, with the wigwag flags, 15x15 inches square, and the heliograph. Night wigwagging is accomplished by means of two lights, or the flash light is used.

Signaling in the marine service has become a refinement, especially in the Navy, as it is the only visible means of communication between vessels. Good vision and the recognition of color are absolutely essential to enable one to understand the various signals.

The signals are fixed and moving. The colors used are white, red,

yellow and green, blue, and various combinations of the above colors. Day fixed signals in which colors must be recognized are bargees, pennants and flags, buoys, etc. Bargees, pennants and flags are of different sizes.

	Size 3		Size 6	
	Hoist.	Fly.	Hoist.	Fly.
Bargee	7.25	7.25	2.90	2.90
Pennant	5.83	18.00	2.00	5.00
Square flag	7.25	7.25	2.90	2.90

These signals are used for communicating in the international code. Storm flags are eight feet square, and pennants eight feet hoist and fifteen feet fly.

"A buoy is a floating object fixed at a certain place to show the position of objects beneath the water, as shoals, rocks, etc., to mark out a channel and the like. . . . In the waters of the United States the following system of placing buoys as aids to navigation is prescribed by law: Red buoys mark the starboard or right-hand side of the channel coming from seaward, and black the port or left-hand side; midchannel dangers and obstructions are marked with buoys having black and red transverse stripes, and midchannel buoys marking the fair-way have longitudinal black and white stripes; buoys marking sunken wrecks are painted green. The starboard and port buoys are numbered from the seaward end of the channel, the black bearing odd and the red even numbers." White buoys are used for special purposes, and yellow mark quarantined grounds.

Moving day signals are the wigwag flags fifteen inches by fifteen inches and the two-arm semaphore flags, which are twelve to fifteen inches square. Night fixed signals consist of light houses, light ships, occulting lights, illuminated buoys, ship's lights, electric night signals, Very's night signals, rockets, and drawbridge lights.

White and red lights are used in the United States Light House Service. Ship's lights are white, red, and green. Electric night signals consist of a system of four double lanterns white and red, in which different letters and figures are indicated by the relative position of the red and white lights, shown when reading from above down. Very's night signals is a system whereby numbers are made by red and green lights fired into the air from a pistol: rockets of various colors are also used. A blue light burned every fifteen minutes is a signal for a pilot. Drawbridge lights are red and green lights which designate the condition of the draw and position of channel.

The rules and regulations for preventing collisions at sea (*Federal*

Statutes, Vol. XI, page 154) describe and give certain specifications as to ship's lights and are as follows:

Article 1. The rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such time no other lights which may be mistaken for the prescribed lights shall be exhibited.

Article 2. A steam vessel when under way shall carry—

(a) On or in front of the foremast, or if a vessel without a foremast, then in the forepart of the vessel, at a height above the hull of not less than twenty feet, and if the breadth of the vessel exceeds twenty feet, then at a height above the hull not less than such breadth, so, however, that the light need not be carried at a greater height above the hull than forty feet, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of twenty points of the compass, so fixed as to throw the light ten points on each side of the vessel, viz., from right ahead to two points abaft the beam on either side, and of such a character as to be visible at a distance of at least five miles.

(b) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least two miles.

(c) On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the port side, and of such a character as to be visible at a distance of at least two miles.

(d) The said green and red lights shall be fitted with inboard screens projecting at least three feet forward from the light, so as to prevent these lights from being seen across the bow.

(e) A steam vessel when under way may carry an additional white light similar in construction to the light mentioned in subdivision (a). These two lights shall be so placed in line with the keel that one shall be at least fifteen feet higher than the other, and in such a position with reference to each other that the lower light shall be forward of the upper one. The vertical distance between these lights shall be less than the horizontal distance.

The above rules are general and only a part of the many which apply to vessels of different sizes, and those employed in the various vocations required upon the sea.

U. S. Navy Department specifications as to colored lenses are as follows:

Colored lenses must be solid color, no flashed lenses being acceptable.

Green lens.—The color shall be that known as "Admiralty green," having a slightly blue tint when tested with a Navy standard 32 c. p. lamp as the source of illumination. The spectrum shall show very little yellow, and shall be a full green with some blue. The total percentage of light transmitted shall not fall below the minimum sufficient to insure a distinct indication at the distance prescribed by the international regulations.

Red lens.—The color shall be of such quality that all the yellow rays of light are absorbed, and the spectrum shall be either red or red and orange when tested with a Navy standard 32 c. p. lamp as the source of illumination. The total percentage of light transmitted shall not fall below the minimum sufficient to insure distinct indication at the distance prescribed by the international regulations.

RAILWAY SIGNALS.

Three distinct forms of signals are necessary in railway operations—"All Clear, Proceed;" "Caution, Proceed Slowly," and "Danger, Stop."

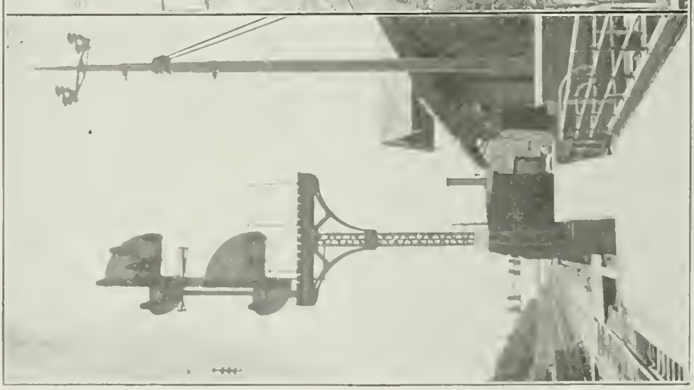
Railway signals are divided into two grand classes, *fixed* and *moving*. It is quite generally accepted that red designates danger; green or yellow, caution, and white or green, clear. Blue is used as a caution signal to indicate repairs being made.

The day fixed signals are flags, switch targets, train order signals, semaphores, interlocking block signals, and drawbridge signals.

Flags.—These are displayed at stations or are placed along the track by trackmen to indicate danger, or caution to regulate speed of trains over a section of track in poor condition, etc. They are also displayed on the pilots of engines as classification signals and on the rear of trains as markers. They are made of bunting about sixteen inches by eighteen inches, and are red, white, green, yellow and blue when new.

Switch targets.—These are used to designate the condition of the switches in relation to the main track or side tracks, and are of three general divisions, high, medium and low, depending upon the height above the road-bed. They indicate the position of the switch-diverting rails by the shape, position and color of the target, which may be square, oval, round, kidney-shaped, an arrow, a bar or feather, etc. The colors used are red, green, white, yellow, black, or any combination

Typical Bridge and Position Light Signals Indicating Three Blocks Clear on Outside Track and Two Blocks Clear on Inside Track. ("The Signal Engineer.")



Bracket Post with Modified Background.

of these colors, according to the judgment of the officers of the various roads.

Train-order signals.—These are used to stop a train to receive orders. They commonly are sheet iron discs of various shapes, attached to station buildings and under control of the station master. The newer forms are semaphore arms attached to the buildings or on a mast isolated from the building. The colors used in the old form are red, green, white, and black, or a combination of the same.

Interlocking signals.—These are usually of the semaphore type, and are located alongside the track on the right-hand side and adjacent to, where possible, or on bridges immediately over the track they govern. The blades are painted red, white, green, yellow and black, or combinations.

These signals are used at points where interlocking plants are installed to protect train movements over intersecting tracks, and, therefore, are extremely important.

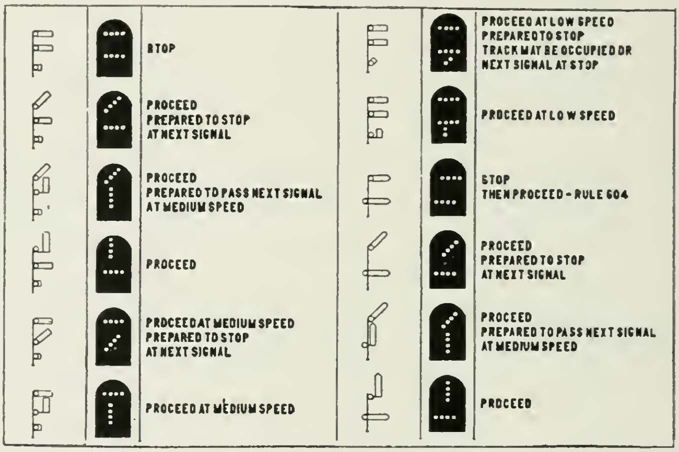
Block signals.—These indicate whether the section of track ahead of them is occupied or not, and are very important signals in this age of limited trains. They are of three types; in the first, the position; in the second, the color displayed gives the information; while in the third, the combination of shape and color gives the indication. The same colors are used as with interlocking signals.

The semaphore is the best type of position block signals, and consists of a tall pole with a blade at or near the top, arranged so that it can be placed at various angles to the perpendicular. These semaphores are used as three-position and two-position signals in block signaling, as well as in interlocking. The three-position signal is of three varieties, i. e., in the first type the blade stands at right angles to the perpendicular for "Stop;" dropped to 45 degrees "Proceed with Caution," and dropped vertically and parallel with the pole for "Clear." In another type the blade is placed horizontally for "Stop:" at approximately 45 degrees with the horizontal pointing upwards, "Proceed with Caution," and at an angle of approximately 45 degrees pointing downward, "Clear." The new upper quadrant system with the blade horizontal, "Stop;" pointing upward at 45 degrees, "Proceed with Caution:" pointing upwards at 90 degrees, "Clear."

With the two-position semaphore the blade is at horizontal for "Stop," and dropped at an angle at from 45 to 80 degrees with the horizontal for "Clear."

The shape of the ends of the blades are usually square, pointed, fish-tail or round (concave or convex), and each shape has a special significance. On roads where pointed blades are used for train order

or block signals the square end blade is used for home signals in connection with interlocking plants. These must not be passed when in the "Stop" position, as they are usually connected with "Derails," and the engineman running by would derail his train, or if derails were not in use would foul a conflicting route. Such signals are often placed before draw bridges, railroad crossings, etc. The fish-tail end is generally used for "Distant signals" when the "Home signal" can not be seen at sufficient distance on account of curves or some obstruction to allow the engineman space in which to stop his train; the "Distant signal" indicates the condition of the "Home signal" or is a repeater.



Corresponding Aspects of Semaphore and Position Light Signals with Their Indications. ("The Signal Engineer.")

"As the color of the blade has nothing to do with semaphore signal indications—position and shape of blade only governing in this matter—the color best adapted to local conditions may be used. On many lines home and advance signal blades are painted red, with a broad white stripe across near the outer end, and distant signals are painted green with a similar white stripe. On other lines orange has been adopted as the color for distant signals. Local characteristics, such as the color of the background and atmospheric conditions, may be allowed to govern, although for many reasons a uniform standard is desirable."

The home interlocking and train order signals are commonly painted red with a white band near the free end, and the "Distant signal" green or yellow with a white band near the end.

There is also a dwarf signal used, which is a miniature semaphore, about three feet in height, and which is used where the train movements are slow or where there is not room for a standard high signal.

The one-armed standard high semaphore pole is usually about 26 feet above the ground. The two-armed is about 32 feet high, and the bracket pole is about 38 to 50 feet, as are also semaphores displayed on bridges. The blades are all about 4 feet in length.

The disc signal.—This is a type of a color block signal and consists of white or transparent background, before which a disc of red or green cloth is dropped, all mechanism being protected by a wood and glass case.

The banner.—This is a type of a shape and color signal, and consists of an oval shaped white disc with a black background, outlined by a white circle in the proceed position, and a red disc outlined by a white circle on a black background in the stop position.

Moving signals.—These consist of red, green, yellow and white flags, and the motions of the arm and hand used by trainmen in transmitting information to the engine crew. The color of the flag affects the indication.

There is a general rule on many roads that the arm or any object waved violently is a "Stop" signal.

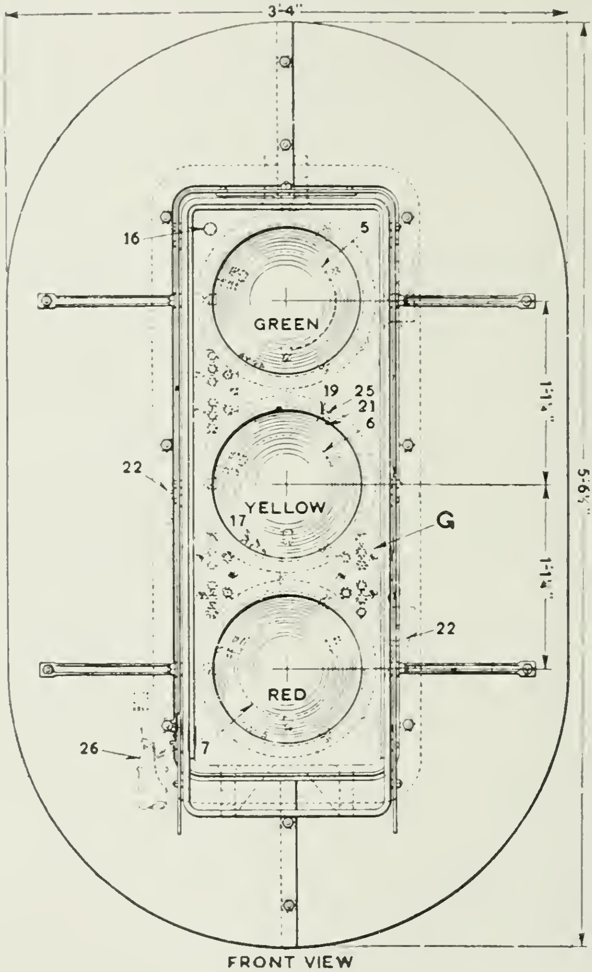
Night signals.—By night, at the present time, information as to the condition of the right of way is given by means of colored lights. As the trainmen are almost entirely dependent on signals at night for information as to track obstructions, location, warnings and means of communication, this is the most important part of railway signaling—it should therefore be the simplest, surest, and have the contrasts most marked. The colors used are red, white, green and yellow.

The principles of night signal indications adopted by the Railway Signal Association are, "red, stop;" "yellow, proceed with caution, expecting to stop at next signal;" "green, proceed." The general practice up to twenty years ago for night signaling was, "red, stop;" "green, caution;" "white, proceed." The change from white to green for the "proceed" indication, and the adoption of yellow for caution, was because of the many incandescent and arc lights on and about the right of way being mistaken for proceed indications. More than half the mileage of this country has now adopted yellow for caution and green for proceed.

The fixed night signals are white, red, yellow and green lights or lanterns, with purple or dark-blue in use for back lights at interlocking plants. Red and green fuzees are used for emergency signals and to indicate track conditions. A red fuzee must not be passed until it is burned out. When burning green it is a caution signal.

The condition of switches is indicated by white, yellow, red or green lamps placed on the top of the targets. Gates and bars are indicated in the same manner.

In all night signaling, while the color is the main indication, the

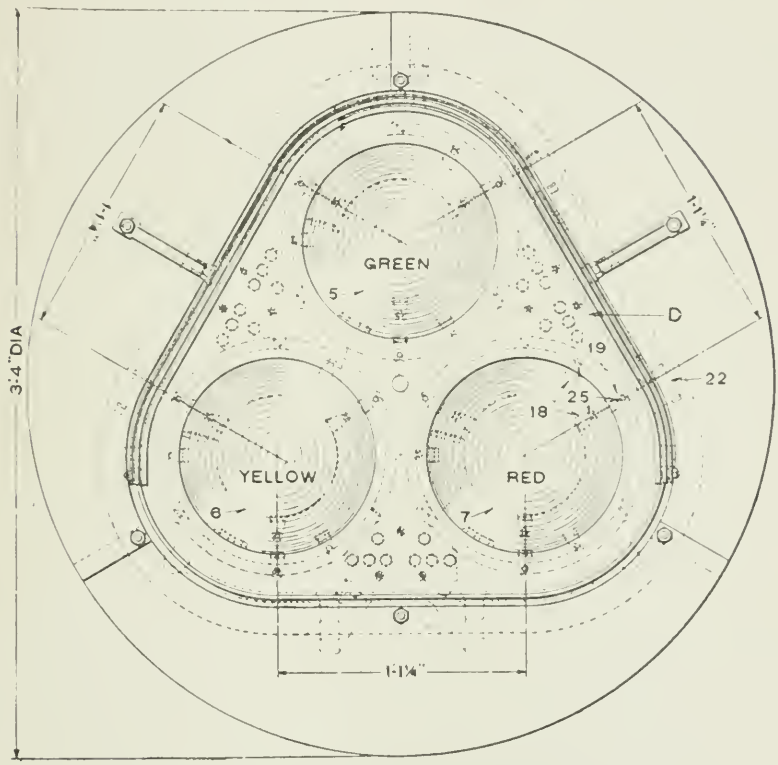


Three-Light Vertical Electric Light Signal Unit.

location of the lights has something to do with determining the meaning of signals, i. e., a red above a white or green will indicate one thing, and a white or green above a red another; hence the necessity for perfect color perception. Yellow is used as a caution signal on roads where green is used for clear. Its usefulness is in case a glass

should break in any signal, a white light would show when it should be yellow, red or green, and indicates that something is wrong. Drawbridge signals are red and green balls in day time and red and green lights at night, usually guarded by a distant signal.

Light signals for day and night indication.—It is interesting to note that in connection with the Philadelphia suburban electrification it was originally decided to employ transverse bridge supports for



Three-Light Triangular Electric Light Signal Unit.

the overhead catenary construction and in order to prevent the interference and liability of error in observing the semaphore arm signals against the background of cross supporting beams, it was decided to employ the electric lamp signal for both night and day. Although experiments subsequently proved the desirability of using transverse cable supports and poles instead of transverse bridges, the advantages of the electric day signal are realized to be so important that the original plan of using this type of signal has been adhered to.

With specially constructed lamps, where the filament is concentrated in helical form so that practically the entire light flux of the lamp is located in the focal zone of the lens, it is found that a one candle power electric lamp will illuminate the signal so brilliantly that it can be readily distinguished at a distance of two miles. This current consumption is so low that it has been decided to burn the lamps day and night and thus eliminate the complication of control circuits.

These small candle power lamp installations were designed to operate in connection with the usual semaphore systems, simply replacing the oil flame as illuminant, but even a more radical departure from past practice is found in the successful trials of powerful electric lamp signals for both day and night use to replace entirely the semaphore arm with its complicated operating and control.

In numerous tests on the Pennsylvania railroad at Pittsburgh where 20 watt Mazda lamps with concentrated filament have been used in connection with 10 in. lens, even in the smoky atmosphere prevalent at Pittsburgh these lamps are easily visible by day or night at from 4,000 to 5,000 feet.

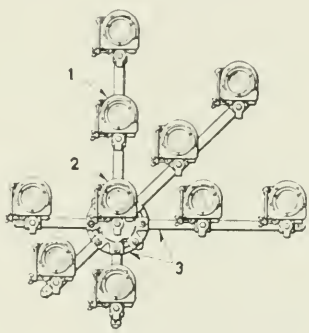
If practical experience proves this system of signaling to be as effective as preliminary tests would indicate it will, no doubt, have a revolutionary effect upon all future signal installations.

The new beam light signal.—The following description is furnished by Mr. A. H. Rudd, Signal Engineer of the Pennsylvania Railroad System:

In place of semaphore block signals, a novel arrangement of lights, uncolored, is used by which both motion and color will be done away with, the lights being used by day and night. "We have developed what we call, for lack of a better name, the 'beam-light' signal, and are to install it between Overbrook and Paoli, about 16 miles of four-track road with five interlockings. The signals will give three-block indications, and will be located approximately 3,500 feet apart. If the scheme proves satisfactory it will be useful especially where A. C. track circuits are installed, as with it the only moving part in the system is the control relay, which is necessary with any system. As designed each unit is generally arranged as shown. Four fixed lights in a row, one light being common to all three rows. The containers for the lamps, lenses, etc., are clamped to steel tubes diverging from a center casting, a suitable background being attached to the center support but back of and separate from the tubes supporting the lamps.

"The lamps are spaced 18 inches apart, center to center, and are 12-volt, 4-candlepower, 5-watt Mazda; concentrated filament with ad-

justable base, burning at 11-volts in bright daylight or in fog, 6-volts at twilight and 3-volts at night. The current consumption will average up about ten watts for the four lights. Special inverted 5⅜ in. lenses and very light yellow cover glasses, commercially known as No Glare Glass, are placed in front of the lamps; and a reflecting mirror above the cover glass to throw some of the rays down for close range. There will be a hood over each unit. These lights are readily seen in brightest sunlight at 4,000 feet or more. Scareheads of newspapers can be read by them at night 1,000 feet away if the full day voltage is used; hence the necessity of dampening down at night. The voltage will be controlled from the nearest signal cabin by the signalman. The entire arrangement is immovable, the rows of lamps



Beam Light Signal Unit.

being lighted as conditions require. Two units will be used on all signals—equivalent to two semaphore arms—thus making a uniform system, the aspects corresponding to the position of the arms as in standard practice, but at interlocking signals the bottom (low-speed) arm will not be displayed in the stop position at all. When it is required two short-range lights will be shown, diagonal or vertical, in addition to the two upper arms horizontal. This is a decided advantage, as the engineman will know that unless two full size beams appear, the signal is improperly displayed. No permissive aspect will be required, but if needed it can be shown by a row of lights diagonal (45 deg.) in lower right-hand quadrant.

"The staggered light effect to distinguish stop and proceed signals from stop and stay will be produced by having the bottom horizontal beam moved to the left one light, the difference being required only in the stop indication.

"For dwarf signals, which cannot be hooded lest close range reading should be obscured, frosted white cover glasses and higher candle-power lamps will be used.

"This arrangement will eliminate all failures due to moving parts of signals and mechanisms (except the relays), and all chances of freezing or sticking clear. From our records it appears that this should reduce all failures, with their consequent delays, at least 10 per cent., and all dangerous failures 40 per cent. The scheme solves the colored-light problem for night indications completely, by eliminating all colors and establishing signaling by position only."

Classification signals. Single track rules are as follows: The following signals will be displayed, one on each side of the rear of every train, as markers, to indicate the rear of the train: By day, green flags. By night, green lights to the front and side and red lights to the rear; except when the train is clear of the main track, when green lights must be displayed to the front, side and rear.

All sections except the last will display two green flags, and in addition, two green lights by night, in the places provided for that purpose on the front of the engine.

Extra trains will display two white flags, and, in addition, two white lights by night, in the places provided for that purpose on the front of the engine.

When two or more engines are coupled, the leading engine only shall display the signals as prescribed.

One flag or light displayed where in the above rules two are prescribed will indicate the same as two; but the proper display of all train signals is required.

When cars are pushed by an engine (except when shifting or making up trains in yards) a white light must be displayed on the front of the leading car by night. Each car on a passenger train must be connected with the engine by a communicating signal appliance.

A blue flag by day and a blue light by night, displayed at one or both ends of an engine, car or train, indicates that workmen are under or about it: when thus protected it must not be coupled to or moved. Workmen will display the blue signals and the same workmen are alone authorized to remove them. Other cars must not be placed on the same track so as to intercept the view of the blue signals, without first notifying the workmen. A combined green and white signal is to be used to stop a train at the flag stations indicated on its schedule. When it is necessary to stop a train at a point that is not a flag station on its schedule, a red signal must be used.

Double track rules are the following: The following signals will

be displayed, one on each side of the rear of every train, as markers, to indicate the rear of the train: By day, green flags. By night, green lights to the front and side and red lights to the rear, except when the train is clear of the main track, when green lights must be displayed to the front, side and rear, and except when a train is turned out against the current of traffic, when green lights must be displayed to the front and side, and to the rear, a green light toward the inside and a red light to the opposite side.

Three and four track rules.—A train by night running with the current of traffic, on a high speed track, will display two red lights to the rear.

A train by night running with the current of traffic, on a slow speed track, or a train by night using any track against the current of traffic, will display a green light to the rear on the side next to the high speed track in the direction of the current of traffic, and a red light on the opposite side.

A train by night on a siding will display two green lights to the rear.

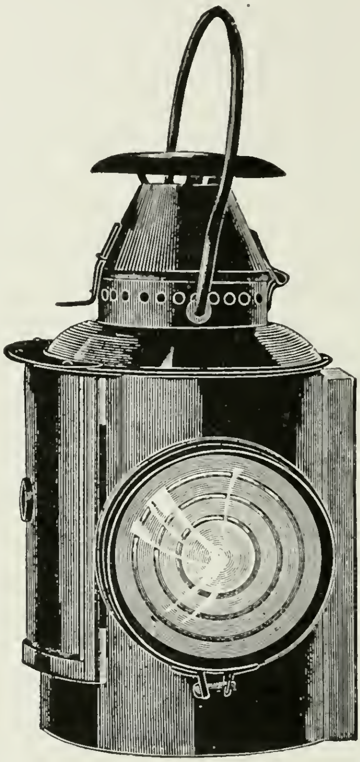
VISIBILITY OF SIGNALS.

As will be seen from the quotation from the foregoing *Federal Statutes,* the visibility of the signal lights on vessels is fixed by law, i. e., a white light must be visible at distance of five miles and a red and green light at a distance of two miles, the word "visible" in these rules when applied to lights shall mean visible on a dark night with a clear atmosphere.

The American Railway Signal Association has adopted specifications for the glass used for signal roundels, lenses and glass slides which give a maximum range for colored signals under all weather conditions. With the source of illumination 40 to 70 candlepower as found in actual practice, depending upon the type and size of burner, the lens, focal adjustment of the flame, the reflector, the conditions of the lamp, etc., such specified red and green glass give signals with an approximate range of three miles in clear atmosphere. The yellow glass is less effective, having a range of 1 to 1½ miles. Blue glass has a very much less range owing to its lessened intensity and low penetrating power. As noted under the description of beam light signals these lights are readily seen in the brightest sunlight at 4,000 feet or more.

The following table gives the spectro-photometric analysis of roundels of the various colors of medium intensity as specified by the Railway Signal Association. The letters indicate the Fraunhofer lines of the

spectrum, and the figures show percentages of light transmission at the different points. Roundels of medium intensity should transmit light as nearly as possible of this composition, a reasonable variation being allowed for light and dark limits.



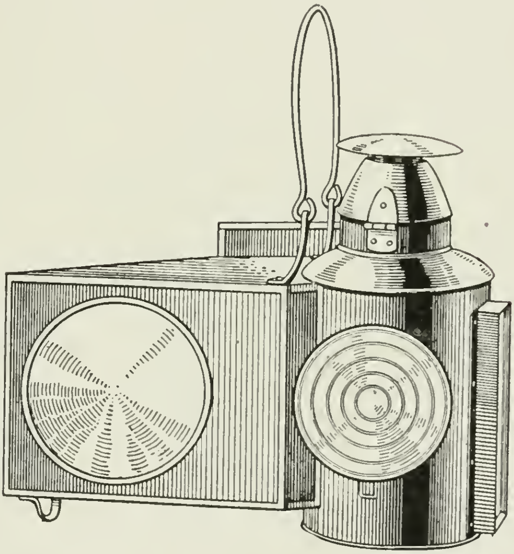
Non-sweating Ventilation Semaphore Lamp, with Corrugated Lens. The source of illumination for night signaling.

	A	a	B	C	D	E	b	F	G	H
Red	60	65	70	72	0	0	0	0	0	0
Green	0	0	0	0	4	27	40	45	25	0
Yellow	0	38	50	43	41	12	9	3	0	0
Blue	0	0	0	0	3	4	6	24	40	46
Purple	0	42	42	0	0	0	0	2	43	42
Lunar white....	0	62	49	17	15	25	38	65	74	0

Red shall be of such a quality that all yellow rays of light are absorbed, the spectrum being either red, or red and orange. The photometric value shall be, light one hundred and thirty (130), standard one hundred (100), dark seventy (70).

Green shall be of the color known as admiralty green, having a slightly bluish tint. The spectrum shall show very little yellow, being a full green with some blue. The photometric value shall be, light one hundred and twenty-five (125), standard one hundred (100), dark seventy-five (75).

Yellow shall give a spectrum showing a full yellow band, most of the red and slightly of the green. The photometric value shall be, light one hundred and twenty (120), standard one hundred (100), dark eighty (80).



Semaphore Lamp, in which Two Colors, Usually Red and Green, are shown at the same time.

Blue shall give a spectrum having a full blue band, with a narrow band of green. The photometric value shall be, light one hundred and twenty-five (125), standard one hundred (100), dark seventy-five (75).

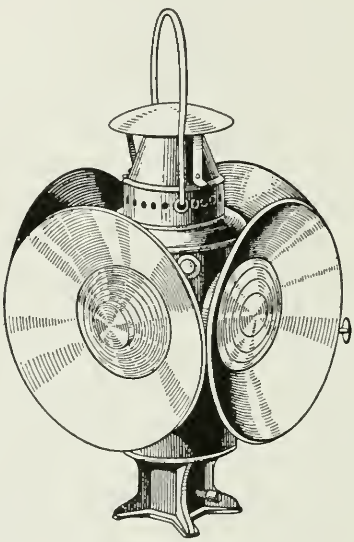
Purple shall give a spectrum showing a considerable proportion of both red and blue. The photometric value shall be, light one hundred and twenty-five (125), standard one hundred (100), dark seventy-five (75).

Lunar white shall show a maximum of absorption for the yellow. The photometric value shall be, light one hundred and twenty (120), standard one hundred (100), dark eighty (80).

The colors transmitted by glass meeting the above specifications are not mixed with white so are in a state of greatest saturation.

The quantity of light of each wave-length transmitted from the source of illumination by each colored glass is shown in the table. The quantity of light transmitted by the red and green roundels is from 25 per cent. to 35 per cent. of the original source, for the yellow 35 per cent. to 45 per cent.

Signal observations must be made by the engineman at a sufficient distance within which to control his train.



Switch Lamp.

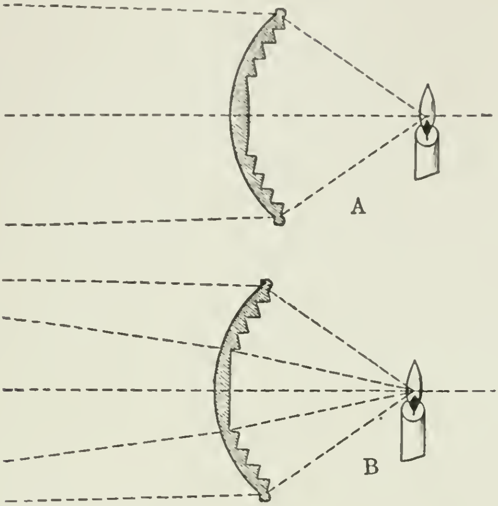
With the ordinary brakes, seventy pounds trainline pressure, a six-car train running seventy miles an hour can be stopped inside of 2,000 feet, approximately 1,900 feet, and when the high-speed brake, 110 pounds trainline pressure, is used, the train can be stopped within 1,527.25 feet.

It will be seen that the significance of the signal must be determined at not much less than one-half mile (2,640 feet), as a few seconds are necessary for the engineman to shut off his steam and apply his air, and in each one of these seconds a train traveling seventy miles an hour is covering practically 103 feet.

A. H. Rudd, Signal Engineer of the Pennsylvania Railroad Com-

pany, states: "We allow 3,300 feet for stopping a train at 70 miles per hour under all conditions."

There is no question that next to the necessary practical knowledge



Cross-section of Lenses Used in Semaphore Lamps in Railway Signaling. A, Optical Lens; B, Wide-angle Lens.

of his engine the vision and color preception of the engineman are the most important.

FACTORS INTERFERING WITH THE VISIBILITY OF SIGNALS.

The atmospheric conditions interfering with the visibility of marine signals are often sufficient to completely obscure them from view, but vessels not being of necessity held to a particular course as with a train can receive and give warnings by means of whistles, bells, etc., etc. Fog is particularly dangerous, as the rays of long wave length are the only ones which can penetrate it and an individual with abnormal color vision having a shortening of the red end of the spectrum would be unable to detect the presence of any light made up of wave lengths which escape being absorbed by the fog. Also those who confuse red and green would be unable to detect a green light where atmospheric conditions were such as to filter out the blue, green, and yellow rays and only allow the orange and red rays to pass.

Conditions existing about an engine, such as the escape of steam when an injector is used, when the whistle is blown, from leaking valves or connections, from the poorly packed piston rods of air pumps,

cylinders, and steam chests, will often completely envelop the engine and cab. Steam and soot from the smoke stack are often blown back against the cab windows, covering them with moisture and dirt and making it next to impossible to see through them, to say nothing of obtaining a view of anything through the condensed steam and smoke. This is especially true in passing through tunnels and under the viaducts or bridges entering the railroad yards of large cities; where there are many moving engines and trains, all signals must be closely watched. In freezing weather the escaping steam is especially bad, as the windows are coated with ice, and vision through them is out of the question. The dust raised by passing trains often coats the windows, especially if they are damp from escaping steam; the engineman's position, being on the right side, escapes most of this, however, on roads which run their trains right-handed on double tracks. The cloud raised from ploughing through snow drifts shuts off all vision for the time. Some considerable complaint is made of the drive wheels of the engine throwing mud and dirt on the front windows in moist weather.

The glare from the furnace door when the engine is stoked makes the recognition of night signals very difficult. There is an iron shield above the furnace door on the engineman's side, which protects him somewhat. Many enginemen have their seats curtained off to relieve them from this glare. After looking into this glow from the position of a fireman during the time required to shovel in five or six shovels of coal, it is an utter impossibility for a novice to read a signal. Firemen state that they cannot even see their steam gauge for several seconds after stoking, and when one takes into consideration that from three to ten tons of coal are handled in a two to five hours' run, there is not much let-up from looking into the fire box, and when this is done daily for five or six years, or even longer, before a fireman can expect to become an engineman, it must be a good pair of eyes that can stand it, without some protection.

The terrific glare from the intense light of acetylene and electric headlights, when running against them on double track roads very seriously interferes with the recognition of color signals. The diverging rays of an intense headlight completely obliterates the less luminous signal lights, such as classification signals. The scotoma produced by a few seconds' regard of these sources of light often lasts several minutes. Phantom signals, the result of reflection from the glass in the semaphores, are complained of in time of sleet, snow, fog or rain; the reflection from these elements prevents observation ahead. Fusees cannot be seen under the rays of the electric arc.

The constant jarring, with the swaying and rolling of an engine traveling at a high rate of speed, is another factor in making signal reading difficult.

The supervision of an engine takes no small part of an engineman's time and attention, and his duties are far more than sitting on a seat and watching for signals. This is especially true when there is any trouble with the various mechanisms under his care.

Certain atmospheric conditions are not only a source of great annoyance in reading signals, but often completely obscure them at a distance sufficient within which to control a train. Fog, snow, mist and rain take precedence in the order given, and when it is necessary for better vision to have the head out of the cab window the impinging of fine particles of snow, mist or rain against the eyes blinds one almost instantly. The force of the wind when running at a high rate of speed causes the tears to flow and blurs the vision after a very short exposure. Night (illuminated) signals are usually seen at a greater distance than the day (position) signals in these atmospheric conditions.

Atmosphere laden with watery vapor such as fog is a great factor in absorbing light, and while the greatest absorption is at the red end of the spectrum with a gradual decrease towards the violet end, light having a preponderance of blue rays such as an arc light has a much shorter range in fog than a light source having a greater intensity in the red end of the spectrum, such as a kerosene flame. There are no recorded data as to range reduction caused by fog, but observation has led to the conclusion that the range of a signal is frequently cut down to 1/20th of the clear weather range, while in dense fog the reduction is probably much more.

Rain and hail do not interfere as much with the range of a signal as other atmospheric conditions; however, tests conducted by the German Light House Board showed 30 per cent. reduction, on an average, in rainy weather.

Snow interferes greatly by accumulating upon the roundels and lenses and markedly reduces the range of a signal if the air is full of flakes.

Dust and smoke in the atmosphere tend to shift the hue of a light toward the red end of the spectrum as they interfere with the transmission of the shorter wave-lengths. Dense smoke has an effect upon the range of a light similar to fog. As may naturally be expected dirty roundels, lenses or reflectors greatly reduce the range as well as change the saturation of the color. Alignment of the semaphore lamp with reference to the track has much to do with the distance a signal

may be seen. The lens is so constructed as to converge the rays of light falling upon it in a relatively parallel beam, a slight deviation in the adjustment of a lamp will throw the axis of the beam off the track as well as reduce the amount of light projected in the desired direction.

Neighboring lights which may be mistaken for signal lights are kerosene, gas, incandescent (carbon), arc and acetylene lamps. This is more liable to occur if there is smoke or dust in the air.

Dusk and early dawn are times of day when signals are most hard to recognize. There is not sufficient daylight to determine the position signals and what daylight there is seriously interferes with recognition of the night signals.

Many of the above conditions not only reduce the range, but diminish the intensity and change the hue of night signals to such an extent that men with even slight defects in their color perception, who easily pass the average examiner, are very liable to mistake the indication.

The foreground and the background of day signals make a great difference with their being easily seen. A sky background is the ideal. Signals displayed on roads running through mountainous country, and especially where there are many curves in valleys, are very hard to distinguish from the elevated position on either side. Woods stripped of their leaves or in full foliage, the proximity of buildings and bridges—all tend to make the position of signals less distinct, while the cross-bars of telegraph poles are very confusing. Undoubtedly night signals are much easier to read, as the contrast is so much greater, but as to their being seen any farther, or so far, atmospheric conditions being the same, is questionable.

The reflections from snow, from a body of water or from the solid green of foliage, running toward the sun when near the horizon, the shimmer in the atmosphere on hot summer days, all are features which add much to the difficulty of seeing signals.

RULES AND REGULATIONS GOVERNING EXAMINATIONS OF VISION IN THE ARMY, NAVY AND TRACTION SERVICES.

Examination as to the visual acuity and color sense of all applicants for army, navy and railway services is practically universal. From reports obtained in 1910 on color-vision tests in use in the principal maritime countries of the world for their merchant service, it appears that Greece and Italy alone have no color-vision test; while the Holmgren wool test, either alone or as an alternative or supplement to other tests, is used in the United Kingdom, Austria, France, Germany, the

Netherlands, Norway, Russia, Sweden, and the United States. Japan also employs a wool test, though not apparently one based on Holmgren's principles.

The following are extracts from the rules issued by the War Department for the *examination of recruits for the United States Army.*

The *visual acuity* of the applicant will be ascertained and recorded in accordance with special instructions issued for that purpose from the War Department. Test each eye separately, carefully covering the other eye with a piece of cardboard. Especial care should be taken to see that the vision in the covered eye is completely occluded.

Examine the eyes for chronic inflammations, triangular or fan-shaped growths on eyeball with the apex encroaching upon the cornea (extensive pterygium), marked squint, and drooping of the upper lid.

The vision of the applicant will be tested as prescribed in paragraph 9 of these rules. Unless a different rule be established by instructions from the War Department, any case having a visual acuity of 20/30 or less in either eye will be examined further to determine the exact cause of the error.

The following minimum visual requirements for recruits are announced and will supersede such requirements of the *Epitome of Tripler's Manual* as are in conflict therewith:

For the line of the Army and for the Signal Corps: 20/40 for the right eye and 20/100 for the left eye, provided that no organic disease exists in either eye.

a. Recruits may be accepted for the line of the Army when unable with the right eye to read correctly all of the letters on the 20/40 line, provided that they are able to read some of the letters on the 20/30 line.

For the Ordnance Department and for the Hospital Corps: 20/70 in each eye, correctible to 20/40 with glasses, provided that no organic disease exists in either eye.

Tests for color-blindness will be made in all cases in which such tests are required by orders or instructions from the War Department.

Each eye will be inspected for evidence of muscular or other defect and for disease, the lids being everted and examined for trachoma.

Color-blindness is a cause for rejection only in the case of applicants for enlistment in those branches of the service for which color-blindness is specifically declared by orders or instructions from the War Department to be disqualifying.

Asthenopia accompanying any ocular defect is a cause for rejection for any branch of the service.

Complete or extensive destruction of the lids, disfiguring cicatrices, adhesion of the lids to each other or to the eyeball, marked inversion or eversion of the eyelids, trichiasis, ptosis, blepharospasm, and chronic blepharitis are causes for rejection.

Epiphora and chronic dacryocystitis are causes for rejection.

Chronic conjunctivitis, acute or contagious trachoma, and pterygium extending upon the cornea are causes for rejection.

Chronic keratitis, deep ulcers of the cornea, staphyloma, and corneal opacities encroaching on the pupillary area and reducing the acuity of vision below the standard are causes for rejection.

Irregularities in the form of the iris and anterior or posterior synechiæ sufficient to reduce the visual acuity below the standard are causes for rejection.

Opacities of the lens or its capsule, sufficient to reduce the vision below the standard, and progressive cataract of any degree are causes for rejection.

Extensive coloboma of the choroid or iris, absence of pigment, extensive or progressive choroiditis and glaucoma are causes for rejection.

Retinitis, detachment of the retina, neuroretinitis and optic neuritis, and atrophy of the optic nerve are causes for rejection.

Loss or disorganization of either eye and pronounced exophthalmos are causes for rejection.

Pronounced nystagmus and permanent or well-marked strabismus are causes for rejection.

The following methods for determining and recording acuity of vision and color-sense are prescribed for the army and will be followed whenever practicable in the examination of applicants for admission to the United States Military Academy and of applicants for commission, promotion and in any case of disease or disability of officers or enlisted men where these senses may be affected:

In case of applicants for enlistment the existing methods of examination will be continued at the general recruiting station, but the methods herein prescribed will be applied at the recruit depots, depot-posts, and other garrison posts.

The test-type should be placed in a good light, about the height of the eye. If the room is not well lighted by daylight, an artificial light with a reflector should be used, as it will be more uniform.

Place the candidate or patient with back to the window or source of light, at a distance of 20 feet, or 6 meters, from the type.

Examine each eye, covering the other eye with a card or an opaque disc in a trial frame. The hand should not be used for the purpose, as it temporarily blurs vision.

The right eye should ordinarily be examined first before the candidate becomes familiar with the types.

The candidate should be directed to read the test-type from the top of the card down as far as he can see, and his acuity of vision recorded for each eye with the distance of 20 feet as numerator, and the proper distance of the lowest line he can read correctly as the denominator of a fraction.

If the acuity of vision is less than 20/20 and is corrected by glasses, the acuity without glasses and with glasses is given and the correcting formula is noted as:

Vision, R. E. 20/40, corrected to 20/20 by—1. D. cy. 180°.

Vision, L. E. 20/100, corrected to 20/30 by—.50 D. cy. 180°—2.00 D. S.

If he cannot read the type at any distance, the distance at which he can count fingers is recorded as: Vision R. E. can count fingers at 20 inches.

If he cannot count fingers, the distance at which a light can be distinguished is recorded.

If a light cannot be distinguished he is recorded as blind.

As the types are memorized easily, they should not be left where applicants can read them, and it is well in examining the left eye to direct that the lines be read from right to left and to use new type in case of doubt, or to expose one letter at a time by means of a small opening in a card or sheet of paper.

A more correct idea may be obtained by having the candidate read from the top of the card down. Do not direct him to read the lowest line he can see, and always use a card having type from 10 feet to 200 feet.

The distance of 20 feet should not ordinarily be reduced, as a shorter distance leads to some error from the action of the accommodation and from the fact that the type may then be within the far point of moderate myopia.

The method of Holmgren (see page 2448, Vol. IV, of this *Encyclopedia*) is used for the *detection of color-blindness* and the tests should be applied to all persons examined for admission to the army and the result recorded.

In recording the results of the examination the terms, "color-sense normal," "color-sense feeble," "incompletely color-blind," "completely red-blind," "completely green-blind," "completely violet-blind" and "completely color-blind" (all colors) will be used.

The following is extracted from the regulation of the Bureau of Public Health Service, relative to making physical examination:

The eyesight will be tested by the test types furnished by the Bureau, and the Holmgren worsted test will be employed in testing for color-sense. The test must be made for each eye separately.

1. A candidate must have at least 20/40 uncorrected vision in one eye and at least 20/70 in the other, and corrected vision must equal 20/20 in one eye and at least 20/40 in the other.

2. The examiner will observe that the Snellen charts used in the test are exhibited to the candidate at a height of 4 or 5 feet from the ground, and at a distance of 20 feet exactly, and this distance must be maintained throughout the test. A good light must fall on the chart, and during the tests charts with different lettering should be employed in such a manner that the candidate cannot become familiar with the letters on the various lines.

3. Each eye should be tested separately by carefully excluding the eye which is not being examined by holding a card before it. No pressure should be exerted, nor should the excluded eye be closed.

4. As soon as the examiner has ascertained the lowest line which the candidate has been able to read, the vision should be recorded in the form of a fraction, the numerator of which will represent the distance at which the test was made, i. e., 20 feet; the denominator, the number on the chart opposite the last line which was read.

5. The fellow eye is now similarly tested.

6. During the performance of the test the lids must remain naturally open, squinting being prohibited. In the event that the candidate is unable to read all the letters on the line designated as his minimum vision, he will be passed, provided he is able to read three of the letters on the next smallest line with both eyes directed on the chart.

Test for color-blindness.—The entire set of worsteds should be spread out on a table before the candidate in good daylight. Each set of Holmgren's worsteds contains three large skeins: No. 1, green; No. 2, rose pink; and No. 3, red.

Test No. 1. Place the large green test skein before the candidate, at a distance of about 2 feet from the others, and request him to select from the heap of skeins all that most resemble the test-skein and place them beside it. The whole test should be based only upon a comparison of colors, and in making it no color should be named. In the first place, it is necessary that the candidate should thoroughly understand what is required of him—that is, that he should search the pile for the skeins making an impression on his color-sense, independent of any name he may give the color, similar to that made by the sample. He should be informed that there are no two skeins exactly alike, and that the only question is the resemblance of the

color. He must therefore endeavor to find something similar of the same shade, something lighter and darker of the same color. If the person being examined does not succeed in understanding this by a verbal explanation, the person making the examination must make the trial by searching for the skeins and placing them by the sample skein, thereby showing in a practical manner what is meant by shade, and then restore all skeins to the pile except the sample.

With test No. 1, the completely color-blind, whether to red or green, will select, with or without the green, some confusion colors, such as yellows, fawns, or grays.

This examination must continue until the candidate has placed near the sample all the other skeins of the same shade as the sample, or else, with these or separately, one of several skeins of the class corresponding to the confusion colors. The candidate who, while not finally placing the confusion colors beside the test-skein, evinces a manifest disposition to do so, has a feeble chromatic sense, and is partially color-blind.

To ascertain the kind and degree of color-blindness present, test No. 2 should be used.

Test No. 2. Thoroughly mix all the colors together. Then place the large rose skein a distance of about 2 feet from the pile of worsteds, and request the candidate, as before, to select from the pile and place with the sample all that look to him to be shades of that color, lighter or darker, until all of the same shades have been placed by the sample, or else, simultaneously or separately, one or several of the confusion colors have been placed by it.

He who confuses the colors in this test, selecting either the light or deep shades of blue and violet, especially the deep, with or without purple, is completely red-blind.

If he selects the light or deep shades of one kind of green or gray, either with or without purple, he is completely green-blind.

The fact that many green-blind select in this test, besides gray and green or one of these colors, also bright blue, has led to misunderstanding. Some have from this concluded that red-and-green-blindness may exist together in the same individual. This conclusion is not correct. Red-and-green-blindness are two sharply-defined species. The characteristics or sign with green-blindness is confusing the rose with gray or green, or both. This confusion is the point to be determined.

Test No. 3. The large red skein is presented to the candidate; it is necessary to have a vivid red color. The red-blind will choose, be-

sides the red, green and brown shades which to the normal sense seem darker than red.

The green-blind will select green and brown shades which appear lighter than red.

Any one of the following defects will be sufficient for rejection, viz.: Impaired vision, color-blindness, chronic disease of the visual organs.

The following are extracts pertaining to vision from the regulations and instructions in relation to the *Physical Examination of Recruits for Enlistment in the Navy and Marine Corps* (1912).

No person other than a medical officer shall be permitted to conduct any part of a physical examination, to make any measurement, or to make an original entry on any medical record of enlistment.

Eyes (absence of ciliæ, tarsal redness, obstructed puncta, corneal opacities, adhesions of iris, defective vision, color-blindness, abnormal condition of conjunctivæ, etc.).

Eyes, blue; gray; blue-gray; yellow-gray; hazel (light-brown); brown; dark-brown; bicolored (as when the pupillary border is of a different color from rest of iris); also state when the two eyes are of different colors.

Medical officers on recruiting duty shall exercise the greatest care and thoroughness in conducting the physical examination of persons presenting themselves for enlistment in the Navy and Marine Corps. While the instructions are applicable in general to all physical examinations, they are intended to cover more particularly the examinations of applicants presenting themselves for original enlistment.

The examination for visual acuteness is of the utmost importance, and shall be conducted by the medical officer with the greatest care and patience. An appreciable percentage of men are the subjects of slight visual defects, and in the cases of many of those presenting themselves for reenlistment and enlistment these defects may not be sufficiently serious to disqualify them for the naval service. The ignorance, stupidity, or fear on the part of an applicant undergoing examination should be taken into consideration by the examining surgeon, and unless the examination is conducted with care and deliberation an applicant may be rejected whose vision is in reality good. Slight errors on the part of the applicant, such as misreading a P or T for an F, provided the majority of the letters or test characters are read with facility, need not be regarded as sufficient cause for rejection. The examination shall be conducted in a large, well-lighted apartment, and the test cards shall be placed in a good light. The applicant stands at a distance of 20 feet, one eye being tested at a time, and the other covered by a card. Vision is to be expressed as

a fraction, of which the numerator shall be the distance at which Snellen's 20-foot test can be determined, and the denominator 20 Normal vision (20/20) for each eye, tested separately, shall be required, but in candidates who are otherwise physically sound a minimum visual acuteness of 15/20 shall suffice. The existence of several minor defects, combined with a visual acuteness of 15/20 in each eye, shall cause the rejection of the applicant.

Color perception is to be always carefully determined. The usual examination is by Holmgren's method.

Special disqualifications. The eye.—Loss of eye, total loss of sight of either eye, conjunctival affections, including trachoma, entropion: opacities of the cornea, if covering a part of a moderately dilated pupil; pterygium, if extensive; strabismus, hydrophthalmia, exophthalmia, conical cornea, cataract, loss of crystalline lens, diseases of the lachrymal apparatus, ectropion, ptosis, incessant spasmodic motion of the lids, adhesion of the lids, large encysted tumors, abscess of the orbit, muscular asthenopia, nystagmus. Any affection of the globe of the eye or its contents; defective vision, including anomalies of accommodation and refraction; myopia; hypermetropia, if accompanied by asthenopia, astigmatism, amblyopia, glaucoma, diplopia, color-blindness.

Special Order No. 79. As it is important that no men be employed as gun pointers, who are materially deficient in eyesight it is directed that all candidates for this position, shall, before being placed in training, be referred by the commanding officer to the medical officer for examination, and that hereafter no man shall be trained as gun pointers who cannot read with the right eye (or the left eye if used in aiming) at 20 feet the line in Snellen's test card, which is normally seen at 15 feet—that is 20/15 vision and a minimum of 20/20 shall be required with the eye not used in aiming.

This degree of visual acuity in gun pointers is deemed necessary in order to eliminate those men having ocular defects, which would tend to prevent continuous accurate aiming during a considerable period of time.

Before each record target practice all qualified and acting gun pointers shall be examined for acuity of vision and the result entered on the Gunnery Record. A report will also be submitted to the Department.

All examinations in connection with this order shall be carried out with the test card well illuminated.

Rules for visual examination of pilots, masters and mates of the marine service. These were kindly furnished by W. Wyman, Surgeon General, Public Health and Marine Hospital Service.

The examinations are made by medical officers of the Public Health and Marine Hospital Service.

The minimum amount of visual capacity required for an applicant for the position of pilot is not less than 15/20 vision in both eyes (not including errors of refraction corrected by glasses).

The visual acuity for pilots, masters and mates is the same.

Any red or green color-blindness is sufficient cause for rejection of the candidate.

The Holmgren worsted tests are employed for testing color-sense, and the eyesight is tested by the use of the Snellen test-type, each eye being tested separately.

Lantern tests are not used in addition to the Holmgren worsted test.

The following is taken from the General Rules and Regulations prescribed by the Board of Supervising Inspectors, Department of Commerce, Steamboat Inspection Service:

Candidates must have normal color-sense. (No method of testing color-sense is given but as the examinations are made by surgeons of the U. S. Public Health Service, the methods described above are probably used.)

Candidates must have, without glasses, at least 20/40 vision in one eye and at least 20/70 in the other. Vision with glasses must be at least 20/20 in one eye and at least 20/40 in the other. If a candidate has at least 20/20 in one eye and at least 20/40 in the other, without glasses, the examination for visual acuity need not be carried further.

Officers of the Naval Militia who are applicants for license as masters or pilots of steam vessels of the Naval Militia, after passing an examination for color-blindness, may be examined by the inspectors as to their knowledge of the pilot rules and handling of vessels; and if the applicant be found qualified in the judgment of the inspectors, he may be granted a special license as master, mate or pilot on such vessels on the waters of the district in which such license is granted and for no other purpose.

No original license as master, mate or pilot of any vessel propelled in whole or in part by steam, gas, fluid, naphtha, also vapor, electric or other light motors, or master or mate of said vessels, shall be granted except on the official certificate of a surgeon of the Public Health and Marine Hospital Service that the applicant is free from the defect known as color-blindness. No renewal of license shall be granted to any officer of the classes named who has not been previously examined and passed for color-blindness.

Any person requiring examination for color-blindness who is living at a distance of 100 miles or more from a surgeon of the Public Health

and Marine Hospital Service may be examined for color-blindness by any reputable physician; and the physician shall furnish a duplicate report of the examination made upon the regulation blanks, one copy of which shall be furnished the applicant and the other sent to the local inspectors of steam vessels to whom the applicant shall apply for such original or renewal of license.

Requirements of the British Naval and Marine Service. The British Admiralty uses for detecting color-blindness the Edridge-Green classification test, with the use of the Edridge-Green lantern. The final test in case of appeal being the Edridge-Green spectrometer.

The English Board of Trade Tests: A committee was appointed by the English Board of Trade in 1910 "to inquire what degree of color-blindness or defective form vision in persons holding responsible positions at sea causes them to be incompetent to discharge their duties, and to advise whether any, and if so, what alterations are desirable in the Board of Trade sight tests at present in force for persons serving or intending to serve in the merchant service or in fishing vessels, or the way in which these tests are applied."

The report of this committee made in 1912 is divided in five parts. Part 1 deals with existing regulations, practice and the results obtained. Part 2 recounts experiments conducted in the open air. Part 3 considers the degree of defect involving incompetency. Part 4 advises certain alterations. Part 5 gives an account of various experiments conducted by the committee.

The committee summarizes its recommendations as follows:

1. When an inquiry is held regarding a shipping casualty, witnesses who give evidence with reference to colored lights should always be tested for form and color-vision.

2. The approximate limits of color defect compatible with efficiency should provisionally be considered to lie between some such values of the illuminosity ratio as 1.5 and 0.85.

3. The wool test should be modified; (a) by substituting a dark-brown skein for the third (deep-red) test skein at present in use; (b) dividing the skeins into specified groups, one group for each test skein, and requiring a candidate to divide each group into two parts, those which resemble in color the test skein and those which do not.

4. That the lantern suggested by the committee be used as well as the wool test.

5. It is unnecessary to reexamine for color-vision a person who has satisfactorily passed both the lantern and wool test.

6. That the 1911 standard of form vision be adhered to (5/5 partly in one eye, 5/10 in the second eye).

7. That any officer whose vision in the better eye is less than 5/10 be considered to be incompetent.

8. Parents and authorities of training-ships should be advised that the eyesight of boys adopting the sea as a profession should be examined by an expert (to exclude hyperopia and defects).

9. That the local tests be left in the hands of the present type of examiners.

10. That these men should receive a careful course of instruction.

11. That a distinction be drawn between "appeal" and "referred" cases of failure to pass the local tests.

12. That an ophthalmic surgeon be added to the present Board of Examiners in appeal cases.

The standards and methods for determining color-defects in Germany: The sole method of examination for color-blindness as prescribed by law on the German railways and in the army and navy is Nagel's plates.

Regulations of the *Austrian Navy* as to color tests: If all the pseudo-isochromatic plates of Stilling (13 Edition) are read correctly and without any hesitation at the prescribed distance, normal color vision is assumed and further examination is waived. If there is an uncertainty or incapability of deciphering some plates, the applicant is rejected. A further test in such cases is made with Nagel's plates to determine the type of color anomaly.*

RAILWAY REGULATIONS OF VISION AND COLOR VISION.

Reports (see Report of Committee on Color-Blindness, *Trans. Ophth. Sec. A. M. A.*, 1914) from 52 railways representing every large system of the United States and Canada show without exception that all roads require visual examinations and use the Holmgren worsted test or one of its modifications for detecting color defects. Eleven railway systems use the Thomson stick or Thomson's set of 40 tagged worsteds, as recommended by the American Railway Association (1905). The majority use the full Holmgren set of tagged worsteds and furnish blanks to record the numbers chosen.

There is, however, no uniformity in the test-skeins used. Those originally recommended by Holmgren were light-green, rose and red. Some roads use green and red only, others green and rose. The majority use the colors as originally recommended. Some add a yellow

*The standards and methods of examination for color defects used in France, Norway, Sweden, Russia, Spain and the Netherlands were not at hand at the time this report was written.

test-skein, some add a blue test-skein and others leave out the red and add yellow and blue skeins.

Directions for carrying out the wool test, with few exceptions, are uniform and follow fairly well Holmgren's directions which make it entirely a comparison test.

A lantern test is always used on 25 roads, 6 roads use a lantern test in special cases and 21 roads never use a lantern test.

Four roads employ oculists, 29 local surgeons and 19 laymen to make the examinations. When the examination is made by a layman every doubtful case is referred to an oculist for final settlement.

A field test or test under actual working conditions is used occasionally in the reexamination of old employes.

The committee on Safety Appliances of the American Railway Association a number of years ago reported unanimously on "Rules Governing the Determination of Physical and Educational Qualifications of Employes." These were adopted by the Association on April 5, 1905.

There was considerable leeway allowed in these rules. This undoubtedly was for the purpose of giving the various roads time to swing into line, as too decided changes could not be expected to be adopted at once, this being the first step of the American Railway Association in this direction.

The rules adopted by the New York Central System February 1, 1908, are the most comprehensive, thorough and fair to the employes in existence. They are herewith copied in full:

Rule 1.—Each person selected to make examinations must first be examined and instructed by an oculist designated by the Company.

Rule 2.—Each examiner should be provided with: (a) A set of Snellen's test types, with at least three cards of each size of letters shown in different combinations (a single line on each card), for testing acuteness of vision. (b) An American Railway Association standard reading card for testing near vision. (c) A Holmgren or Thomson color-selection test, and instructions for use of same. (d) A Williams lantern, or one similarly constructed, and instructions for use of same. (e) A pair of spectacles, or shade, for testing each eye separately. (f) A triple grooved trial frame with one pair of plus two diopter lenses, one pair of plus one diopter lenses, and one pair of plane glass roundels. (g) Blank forms for examinations, and certificates.

Rule 3.—Examinations should be conducted in a room, or car, in which a distance of twenty feet can be measured from test type, or

face of lantern, to candidate; shades or curtains should be provided in order to darken the room, or car, for the lantern test.

Rule 4.—In testing vision, color-perception and hearing, only the person to be examined and the examiners should be in the room or car at the time, except that if an employe so desires, he shall be permitted to call in another employe who has successfully passed to witness the examination.

Rule 5.—(a) The result of each examination must be shown in duplicate on the prescribed form, one copy to be preserved for reference by the examiners, the other to be forwarded to the division superintendent for inspection, record and file. (b) Those charged with the duty of making examinations on each division must keep proper check to insure reexamination of all employes when due, and must see that all employes who should be examined by an expert or oculist under the rules, are required to take such examinations promptly, and that all glasses to be used by employes are sent to the oculist for approval as per rule 11. (c) Examiners will issue to each person who passes a satisfactory examination, a certificate to that effect, and will, if desired, furnish employes who fail to pass, a written statement of their rating and cause of failure. (d) Division Superintendent must report to the General Superintendent all cases wherein an employe should be examined by committee, or appears to be disqualified, giving full information as to result of examination. (e) Oculists or experts will report result of their examinations to the Division Superintendent.

Rule 6.—All persons desiring to enter the service (applicants) must take entrance examination without the use of glasses for distant vision, excepting Class E.

Rule 7.—Applicants for entrance to service as Enginemen, Firemen, Trainmen or Brakemen, will not be accepted if they have to use glasses for near vision. Applicants for other positions, and employes in all branches of the service, may use glasses for near vision when undergoing examination.

Rule 8.—When the distant vision of an employe can be improved by the aid of glasses, he should wear them, except yard brakemen, who are prohibited from doing so.

Rule 9.—All employes who require the aid of glasses for distant vision must wear them at all times when on duty and must carry a duplicate pair for use in case of emergency, and will be examined with each pair.

Rule 10.—All employes, excepting those indoors, who are permitted to wear glasses for distant vision, when on duty, must use the spec-

tacle or automobile goggle form. There is no objection to the use of automobile goggles fitted with glass for protection of the eyes in engine or freight train service. The use of amber glasses by firemen, as a guard against temporary fire blindness, is encouraged.

Rule 11.—Glasses of all kinds must be approved by an oculist designated by the Company.

Rule 12.—Applicants having a squint, or who are cross-eyed, will not be accepted. Examiners who suspect a case of double vision should use some simple test to determine its presence.

Rule 13.—Enginemen who have less than 20/30 vision in either eye, without glasses, must be examined by an expert or by an oculist designated by the Company.

Rule 14.—Enginemen in Class A, who fail to reach required standard, must be examined by a committee of two, appointed by the General Superintendent, and upon recommendation of this committee they may be permitted to wear glasses, provided their combined vision can be brought to 20/20; committee to recommend service to which they may be assigned.

Rule 15.—Enginemen in Class B, whose vision without glasses is less than 20/50, and either eye less than 20/70, or nil, must be examined by a committee of two, appointed by the General Superintendent, and if the vision by the aid of glasses can be brought to 20/30, must wear glasses; committee to recommend service to which they may be assigned. See rules 13 and 16.

Rule 16.—Enginemen having 20/20 vision in one eye and less than 20/70, or nil, in the other, must be examined by a committee of two, appointed by the General Superintendent; committee to recommend the service to which they may be assigned.

Rule 17.—Where promotion standard is not specified, employes applying for transfer from one kind of service to another, or being promoted, must pass entrance examination of class they desire to enter, except that those who have been injured in service, or who have been in continuous service for at least two years, may be transferred to positions as hostlers, switch tenders and crossing flagmen; also from one position to another under Class E, upon passing the respective re-examination standards.

Rule 18.—An employe in Class C, D, E, or F, who has been in continuous service for a period of not less than fifteen years, and who, through diminution of vision, or muscular imbalance, fails to reach required standard, will be considered satisfactory if his acuteness of vision, with or without glasses, reaches the maximum standard specified for the class of service in which he is employed.

Rule 19.—The test type should be in good light, the bottom of the card about on a level with the eye. Place the candidate twenty feet from the card and ask him to read the type with both eyes open, then cover one of his eyes with a card, or shade, held firmly against the nose, taking care not to let it press the eye-ball, and instruct him to read with the other eye such type as may be indicated. Each eye should be tested separately. (a) Examiners are reminded that the normal-eyed should read the twenty-foot (or 6 meter) letters at 20 feet, in which case the visual power should be expressed by the fraction 20/20. Should a candidate be unable to read the twenty-foot letters at 20 feet, but be able to read the thirty-foot letters, result should be indicated by the fraction 20/30. If he can only read the forty-foot letters record should be 20/40, etc. (b) The candidate, as provided in Rule No. 7, must be able to read the print in paragraph No. 2 of the Standard Card at a distance of from fourteen to eighteen inches to pass the test. Further tests should be made by having the candidate read written train orders.

Rule 20.—Applicants for entrance to service in Classes A and C, will undergo additional test to ascertain if far-sighted to the extent of two diopters. Examiners will use combinations in trial frame representing plane and convex lenses, varying the test so that a candidate's former experience or knowledge obtained from others may be valueless. If an applicant reads without difficulty the twenty-foot letters at 20 feet through convex lenses of 2D, he will not be considered satisfactory.

Rule 21.—Examiners will adhere to instructions laid down by Holmgren or Thomson in using color-selecting test, and will examine the color-sense of each eye separately. Further examinations will be made with Williams lantern, or one similarly constructed, in the manner specified by Dr. Williams.

Rule 22.—No applicant will be accepted into the service, and no employe retained in any of the classes specified in following standards, who has defective color-sense.

Rule 23.—No employe will be disqualified from service by reason of defective color-sense without an examination by an oculist designated by the Company.

Rule 24.—In examination of hearing (which will be with human voice) each ear will be tested separately, and the candidate should not see the movement of examiner's lip.

Rule 25.—Applicants for entrance to service must be able to hear and repeat an ordinary conversation, or names and numbers spoken in a conversational tone, at a distance of 20 feet, in which case the hear-

ing should be expressed by the fraction 20/20. Where conversation can be heard at only 10 feet, the hearing should be expressed by the fraction 10/20.

Rule 26.—Employes will not be retained in the service if hearing is less than 15/20 in one ear and 5/20 in the other; or less than 10/20 in each ear.

Rule 27.—Employes included in the standard of vision must be re-examined as follows: (a) All classes every two years. (b) Employes in engine, train or yard service, who wear glasses for distant vision, enginemen having less than 20/30 vision in either eye, and other employes who have less than 20/70 vision in either eye, must be examined annually. (c) After any accident, in which they are concerned, which may have been caused by defective vision, color-sense or hearing. (d) After any serious accident or illness or severe inflammation of the eye or eyelids. (e) Before promotion. (f) Employes with hearing less than 20/20 in either ear must be examined semi-annually.

Rule 28.—(a) Employes in Class A or B, who are examined by a committee, shall be given an outside or field test. A bracket pole with two dolls or two straight poles (spaced the same distance as dolls on the standard bracket pole), carrying four standard semaphore arms and lights will be used. A clear sky back-ground, tests to be made standing. (b) In making the test candidates should approach the signals from a point where they are unable to see them and not be credited with being able to read the signals unless they can promptly call changes as made in position of arms and color of lights. (c) The test with and without glasses should be made at distances varying from 5,000 to 200 feet. (d) Committee to record the different distances at which the employe being examined can promptly see the signals, and will forward this information, together with their recommendation as to the service to which he may be assigned, to the General Superintendent.

The standard required in railway service throughout the United Kingdom is normal color-perception. The *minimum* visual acuity does not vary greatly from the standard required in the United States and Canada. The wearing of glasses is forbidden. The methods of determining color-defects vary with different roads, the majority using the Holmgren wool-test or some modification. A few used cards on which four colors are printed, or a board placed at 30 feet distant with a number of colored spots painted on it. Others use a tube 20 feet long at the end of which is a revolving disk containing a series of colored glasses. In many instances these tests are supplemented with some lantern test, the final test on a few roads, in case the question of

STANDARDS OF VISUAL ACUITY INDOOR TESTS

CLASS	ENTRANCE TO SERVICE	PROMOTION	RE-EXAMINATION
Class A Enginemen, road service. Hostlers who run on main track.	20 2 combined, not less than 20-30 in either eye, without glasses. Must not accept a plus 2 D lens.	20-20 combined and not less than 20 40 in either eye without glasses.	20-20 combined, not less than 20-70 in either eye; or 20-30 combined, not less than 20-40 in either eye, without glasses. See rules 8, 13, 14 and 16.
Class B Enginemen, yard service. Hostlers who do not run on main track.			20-30 combined, not less than 20-50 in either eye, without glasses. When combined vision without glasses is not less than 20-50, and neither eye less than 20-70, and by the aid of glasses combined vision can be brought to no less than 20-30, enginemen must wear glasses. See rules 8, 9, 10, 11, 13, 15, and 16.
Class C Firemen. Trainmen. Freight Brakemen. Yard Brakemen. Switchtenders.	20-20 combined, and in each eye, tested separately, without glasses. Must not accept a plus 2 D lens.	20-30 combined, not less than 20-40 in either eye, without glasses.	20-30 combined, not less than 20-40 in either eye, with or without glasses, providing neither eye is less than 20-70 without glasses; or 20-20 in one eye and less than 20-70 or nil in the other, without glasses. See rule 8—(Yard Brakemen).
Class D Passenger Conductors. Freight Conductors. Yardmasters. Yard Conductors. Train Baggagemen.	20-20 combined, not less than 20-30 in either eye, without glasses.	20-30 combined, not less than 20-40 in either eye, without glasses.	20-40 combined, not less than 20-50 in either eye, with or without glasses; or 20-30 combined, not less than 20-70 in either eye, with or without glasses; or 20-20 in one eye and less than 20-70 or nil in the other, without glasses.
Class E Station Agents. Telegraph Operators. Signal Foremen. Signalmen. Bridge Foremen. Track Foremen. Drawbridge Tenders. Car and Engine Inspectors.	20-30 combined, not less than 20-40 in either eye, with or without glasses.	(See Rule 17.)	20-30 combined, not less than 20-70 in either eye, with or without glasses; or 20-30 in one eye and less than 20-70 or nil in the other, without glasses.
Class F Crossing Flagmen and Gatemen.	20-40 combined or not less than 20-50 in either eye, without glasses.	(See Rule 17.)	20-50 combined, not less than 20-70 in either eye, with or without glasses; or 20-40 in one eye and less than 20-70 or nil in the other, without glasses.

FIELD TESTS

CLASS		WITHOUT GLASSES	WITH GLASSES
Class A Enginemen, road service.	By day, sunlight.	200, 400 and 2,600 feet.	200, 400 and 5,000 feet.
	Or by day if cloudy, with clear atmosphere.	200, 400 and 2,000 feet.	200, 400 and 4,000 feet.
	By night.	200, 400 and 2,000 feet.	200, 400 and 4,000 feet.
Class B Enginemen, yard service.	By day or night.	200, 400 and 800 feet.	200, 400 and 2,600 feet.

defective color-perception arises in the reexamination of an old employe, being to place the examinee on an engine accompanied by an official of the road and have him call signals as they appear on an average run. The Edridge-Green method of testing has been adopted by a number of English railroads. This method consists of a "classification test," which is regarded only as supplementary to the lantern test.

The final test in case of an appeal or a questionable color defect is the Edridge-Green color-perception spectrometer. Most of the English railways employ qualified ophthalmologists to conduct the examinations.

The regulations of the Austrian Railways of 1909 prescribe two methods of examination for color-vision. (1) Stilling's pseudo-isochromic charts, Nagel's charts and the wool plates of Reuss. (2) Holmgren's worsteds. If there is the least suspicion of abnormal color-sense, the applicant is referred to the chief surgeon for examination with Nagel's anomaloscope. Railway surgeons must undergo an examination for color-vision and if any abnormality is discovered are not allowed to make color tests. If employes are found to have normal color-sense upon each of three examinations further reexamination as to color-vision is omitted.

The Swiss regulations require color-vision examinations by means of Holmgren wools and Stilling's color charts and a practical test for Engineers with flags at 250 meters and lanterns at 400 meters. The Commission of Swiss Ophthalmologists in 1913 recommended Stilling's charts for general examinations, Nagel's plates to determine the nature of the color anomaly and as an accessory Holmgren's worsteds and the color mixing apparatus of Eversbusch. All doubtful cases to be examined by Nagel's anomaloscope.

The regulations for testing the eye sight of employes of the Dutch State Railways are, (a) for the post of engine driver or fireman, externally healthy eyes and eyelids, free from chronic congestion or inflammation. With both eyes open; an unrestricted field of vision, normal acuteness of vision, normal refraction and power of distinguishing colors of at least four-fifths. In looking with each eye separately, the other being covered; unlimited field of vision, acuteness of vision (without glasses), as well as color-sense of not less than one-half. (b) For the post of station-master and his substitutes, petty station-master, head conductor, conductor, brakesman, pointsman, foreman, bridge watcher, signalman, assistant bridge watcher, surface-man and surface-woman, assistant watchman, line surveyor, chief snow ploughman, inspector of the locomotive and train service, and

inspecting engineer, externally healthy eyes and eyelids. In looking with both eyes simultaneously, unrestricted field of vision, normal visual acuteness (without glasses), and free from hypermetropia of more than one diopter, power of distinguishing colors of at least three-fifths. In looking with each eye separately, the other being closed; visual acuteness (without glasses) and color-sense not less than one-fourth; both eyes free from progressive ailments.

If the person examined should appear to be unfit for class a, it must be specified on the certificate whether the candidate is fit for class b.

The visual acuteness is estimated by Snellen's optotypes, or with letters which correspond therewith in size and clearness, at a distance of six meters, first without glasses then with glasses, by which means the refraction also is ascertained. The test types are to be suspended in a good clear light; the person to be examined standing with his back to the light.

The color-sense is estimated qualitatively, by the pseudo-isochromatic tables of Stilling, and with wools, according to Holmgren's method. Quantitatively, by Donders' method, which must be applied in every instance.

The following are the recommendations of the Committee (C. H. Williams, Nelson M. Black and J. Ellis Jennings) on Standards and Methods of Examining the Color Vision appointed by the Ophthalmic Section of the American Medical Association (1914):

1. In every case the color-sense should be examined by the Holmgren worsteds exactly according to the directions given. As some cases of defective color-sense may occasionally pass the Holmgren test it is necessary that another test with a lantern should be used in every case to determine the color-sense of the macula region where the colors of signal-lights must be quickly recognized.

2. (a) Those who pass the test with the worsteds and with the lantern, without making a mistake, should be classed, for signal purposes, as normal. (b) Those who make the characteristic mistakes in selecting colors which look like the green, or the rose test-skein, of the Holmgren worsteds, or, who make mistakes in naming the colors of the lantern, should be classed as abnormal. (c) Of the abnormal cases: Those who select with the green test-skein some greens and also some grays, browns, rarely a red, or who select with the rose test-skein some rose or red colors, and also blues, purples, grays or greens, or with the lantern test call a red light green or white, a green light red or white, or a white light red or green, should be classed as dangerously defective in their color-sense.

Those who make other mistakes than the foregoing, or who are very

hesitating in their selection or naming of colors, should be classed as having a weak color-sense. If these persons wish to work where they will use colored signals, they should be reexamined under medical supervision by repeating the tests with the Holmgren worsteds, and the lantern; and in addition with Stilling's plates (Fourteenth edition, 1913), and also with some form of spectroscope test to determine the extent of the visible red end of the spectrum, and, if possible, with Jenning's self-recording worsted test, and with the Nagel anomaloscope.

3. Cases of appeal from the original examination should be reexamined as provided in the foregoing paragraph.

4. Some plan should be adopted to ensure a proper and uniform standard in the colors of the worsteds, especially the green and the rose test-skeins, and in the colors of the lantern.

5. On large railway systems, and in the marine service, there should be some central point where a complete equipment can be maintained in charge of a competent medical examiner, for the reexamination of doubtful or appealed cases. There should also be a periodic examination by such examiner of all the equipment used in these tests over the whole system, to be sure that it is kept in proper condition and renewed when necessary.

6. Reports of the examinations should be kept on file at some central point and should be supervised by some competent medical authority to see that the tests are made according to the instructions.

7. The Section of Ophthalmology should adopt some standard form of instructions and record blanks which may serve as a guide for those who make the tests.

It will be noted that in the foregoing recommendations no mention is made of red-blind, or green-blind, or blue-blind. The border-lines between the various forms of defective color-sense are not sharply marked, and with the means at the disposal of the examiner in making the routine tests of large numbers of men, it is not possible for him to determine with certainty the exact quality of the defective color-sense, nor is it essential. It is sufficient if he can pick out those who are dangerously defective in their color-vision, or who need a further special examination, and your Committee believes that a careful study of its report, and a strict compliance with the methods and standards there explained, will enable the examiner to make these tests for color-vision fairly and accurately.

The following are the proposed Rules and Regulations to be adopted by the *Association of Railroad Chief Surgeons* (1915).

Classification. I. All those handling trains and train signals, i. e., Engineers, Firemen, Motormen, Engine Hostlers, Conductors, Brake-

men, Flagmen, Train Porters, Yardmasters, Switchmen, Signalmen and Towermen. II. Station Agents, Telegraphers, Train Telephone Operators, Station Baggagemen, Switch Tenders, Section Foremen, Bridge Foremen, Railroad Crossing Flagmen, Watchmen and Crossing Flagmen. III. All other employes.

Requirements. (I) Vision: Normal (20/20 required in each eye.) Firemen and Engineers entering the service must be tested with plus 2d lens, and if able to read 20-foot line, must be rejected. Hearing: Normal (Whisper at 20 feet, acoumeter or watch at 20 inches.) Color perception: Normal. (By worsted and lantern.) Note: Firemen for promotion to Engineers, and Brakemen for promotion to Conductors, must have combined vision of 20/20, provided vision in one eye is not less than 20/40 without glasses. Physical defects: All physical defects tending to impair the efficiency of the individual disqualify. Re-examination: Re-examination of employes in this class must be made once every three years. Vision—Only those whose vision does not fall below normal in one eye and 20/40 in the other may be allowed to hold preferred or main line runs. Hearing—One-half of the requirements for entrance to service. (II) Vision: 20/20 required in one eye and not less than 20/30 in the other. Hearing: Normal. (Whisper at 20 feet, acoumeter or watch 20 inches.) Color perception: Normal. (By worsted and lantern.) Physical defects: All physical defects tending to impair the efficiency of the individual disqualify. Re-examination: Re-examination of employes in this class must be made once every three years. Vision—Combined vision must be 20/30 and not less than 20/40 in one eye with or without glasses. (III) Vision: Combined 20/40, not less than 20/70 in one eye without glasses. Hearing: One-half normal. (Whisper at 10 feet, acoumeter or watch 10 inches.) Color perception: Car-repairers and others whose duties require handling of signals (flags or lanterns) must have normal color perception. Physical defects: All physical defects tending to impair the efficiency of the individual disqualify. Employes over fifty (50) years of age, or employes who require glasses to bring their vision to standard, must be examined every year. Employes who have suffered severe injury or illness must be examined before they re-enter the service.

Rules for Visual Examination of the Employes of The Milwaukee Electric Railway & Light Company (Kindly furnished by Dr. Chas. H. Lemon, Chief Surgeon).

1. Motormen must have 20/20 vision in each eye; no exception made to this rule. They are re-examined when they go on the interurban service and the same requirements are observed, 20/20 vision.

2. Conductors must have 20/20 in one eye and not less than 20/30 in the other eye. When they are re-examined for the interurban service 20/30 in each eye is accepted.

3. The eye test is made by a trans-illumined chart, furnished by F. A. Hardy & Co., the illumination of the chart being designed by the Holophane Company.

4. No re-examination of motormen and conductors is made unless specific complaint is made.

5. For the color test, a card having various colored yarns upon it is used and the men are required to name the colors. If they name these colors without hesitation they are passed, if they hesitate they are given the usual Holmgren test.

6. Men are not accepted who wear glasses for the correction of any visual defect. If they need glasses after serving a few years they are permitted to wear them. Experience of twelve years has demonstrated that the men themselves are more satisfied with the results obtained by the trans-illumined chart than they were formerly with the cardboard chart which grew yellow with age and had a light thrown upon it.

In the United States many of the railway lines are so long that it is impossible to have all the candidates for examination or employes for re-examination come to the terminal offices or where their ophthalmologist is located. In order to overcome this they have provided a car equipped for the purpose which goes over the line at stated intervals. The following is a description by Dr. W. R. Parker of the car used by the Michigan Central Railway in which visual examinations are conducted: "An ordinary day coach was partially dismantled by taking out all the seats except eight, which are left at one end of the coach to serve as a waiting room. Just forward of the seats fifteen feet from the rear end of car, leaving room to pass out of the hallway at the side, a partition is built from the side of the coach to the partition which runs lengthwise of the car twenty-five inches from the side. At a distance of nine feet nine inches from the front of the car a partition is built across from the side to the hall partition, forming a small L-shaped room which is used as a dark room, the windows are carefully covered and an oil lamp set in a swinging bracket. Doors are so arranged that employees enter the testing room from the waiting room; and after the examination is completed they pass out into the hallway and out of the front of the car, thus preventing intercourse with the unexamined. In testing the color-sense in the day time by the use of the Williams' lantern it is necessary to hang the lantern in the dark room opposite the door. By the means of ordinary curtains in

the testing room, the room will be made dark enough for accurate results."

Vision of automobile drivers. Owing to the rapidly increasing numbers of automobiles, used for business as well as pleasure purposes, every state should require that all applicants for a license to drive a motor vehicle pass an eyesight test. Yet, in the great majority of states, the prospective driver of an automobile need only affirm in his application that he has no physical or mental infirmities. When one stops to consider that a railroad engineer drives over a steel track, guarded by signals and watchmen, and over a route with which he is thoroughly familiar, whereas the autoist drives over any road he chooses, not protected by lights and signals, and in some cases traveling almost as rapidly as a locomotive, it is plainly imperative that he possess as good sight as the man in the engine cab. If one eye is highly defective the field of vision is greatly impaired and the driver less able to maneuver his car in an emergency. Paris, Munich and other European cities have seen the necessity of an examination of the eyes of all taxi-drivers and are strict in the enforcement of this protective measure. It is more than likely that defective vision is next in order of frequency to the overuse of alcoholic drinks as a cause of automobile accidents. We can, and should, protect pedestrians and drivers of vehicles from injury to a much greater extent than we do. Each applicant for a license to drive a motor vehicle should be required to give satisfactory proof of at least moderately good vision.

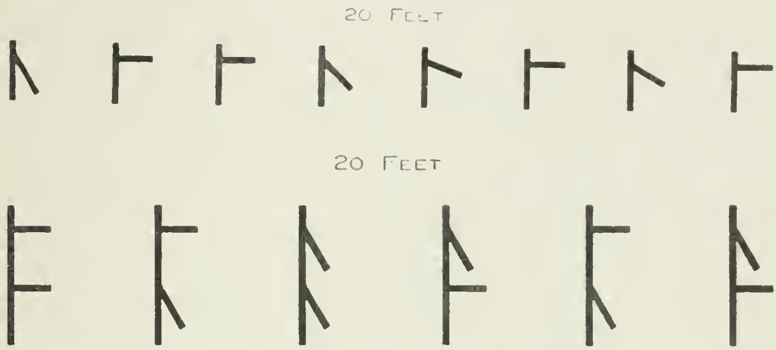
TESTS OF THE VISUAL ACUITY.

Visual acuity tests are as a rule made with the Snellen optotypes. the letters or characters subtending a visual angle of 5 minutes and each stroke of the letter or character subtending a 1 minute angle at the specified distance they are to be used. The broken ring of Landolt adopted by the International Ophthalmological Congress as the International Standard Test for Visual Acuity is used in some instances on the continent. Some railroads in England use a card shown at 15 feet upon which are printed in an irregular pattern black squares $\frac{1}{5}$x$\frac{1}{5}$ inch in size, the examinee being required to count the number of squares exposed. "With perfectly acute vision these test dots ought to be clearly visible in full daylight at 19 yards."

Chas. H. Williams devised what is designated as a "semaphore chart" consisting of a white card upon which are printed black figures representing semaphore signals with the blades in different positions.

When seen at a distance of 20 feet the semaphore signals correspond to the apparent size of a standard semaphore arm 46 inches long seen at a distance of ½ mile.

This chart was improved by Nelson M. Black who has had reproduced a scale-reduced fac-simile of the Chicago, Milwaukee & St. Paul



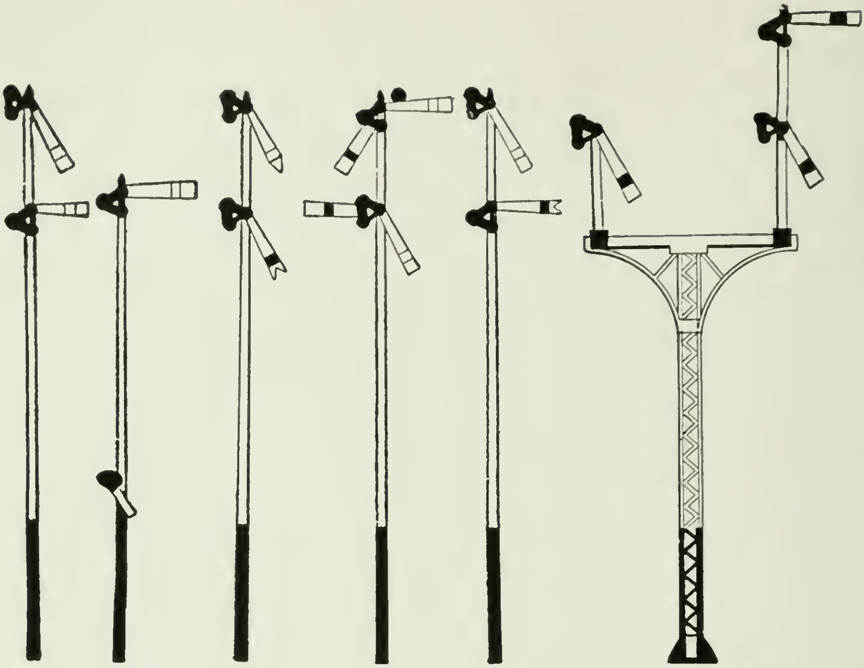
Williams Semaphore Charts.

Ry. block signals which at 20 feet represent a standard semaphore pole and arm seen at one-half mile (2640 feet) with actual colors used for distance and home signals, placed upon a neutral grayish background, which corresponds to the average tint of the horizon against

Williams New Model Semaphore Charts.

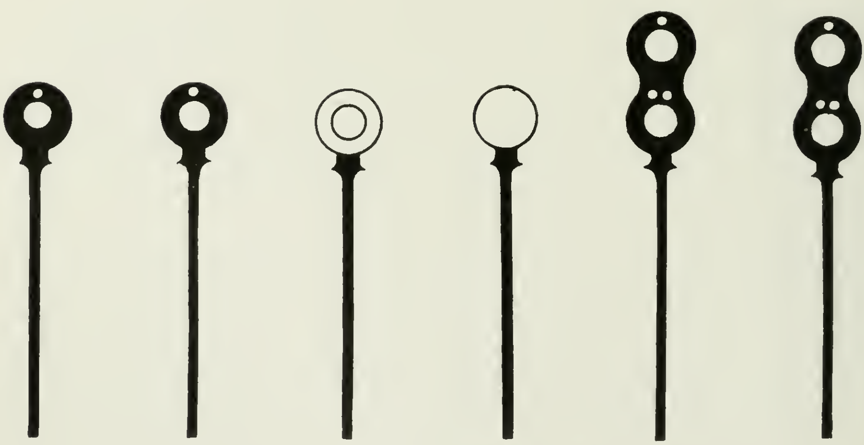
which a semaphore in an ideal position is seen. In this reduced figure, at 20 feet the arm of the semaphore subtends an angle of 0°-5′. The person examined is requested to state the position of the blade, whether "up or down" or may state "Caution," "Clear" or "Danger," depending upon the usage on this particular road for which they are being examined.

With the Hall or "banjo" signal chart the color of the disc exposed



Black's Semaphore Charts.

(For testing the vision of railroad employes.)

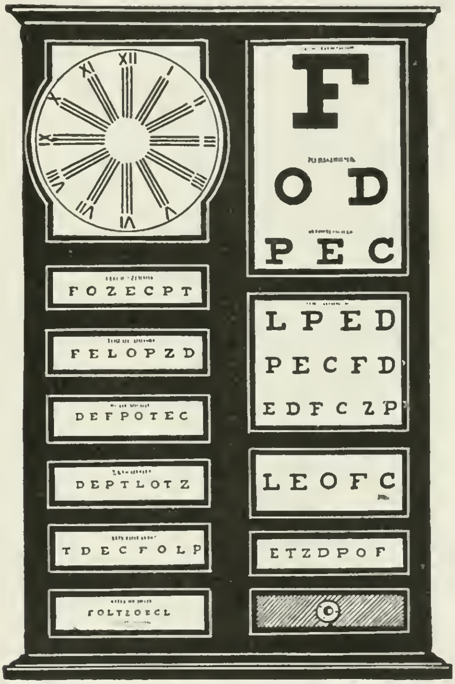


Disc or Hall Charts for Testing Vision of Railroad Employes.

The center areas of the charts are colored red and green for various indications.

gives the indication. The examinee may either name the color or state whether the indication is "Danger, Caution or Clear." (Williams has recently gotten out a new form of semaphore chart, which shows reproductions of two-position semaphore signals.)

The above mentioned visual test charts are all seen by reflected light and, especially when used with daylight, naturally vary in visibility with the intensity of light reflected from their surface. To overcome



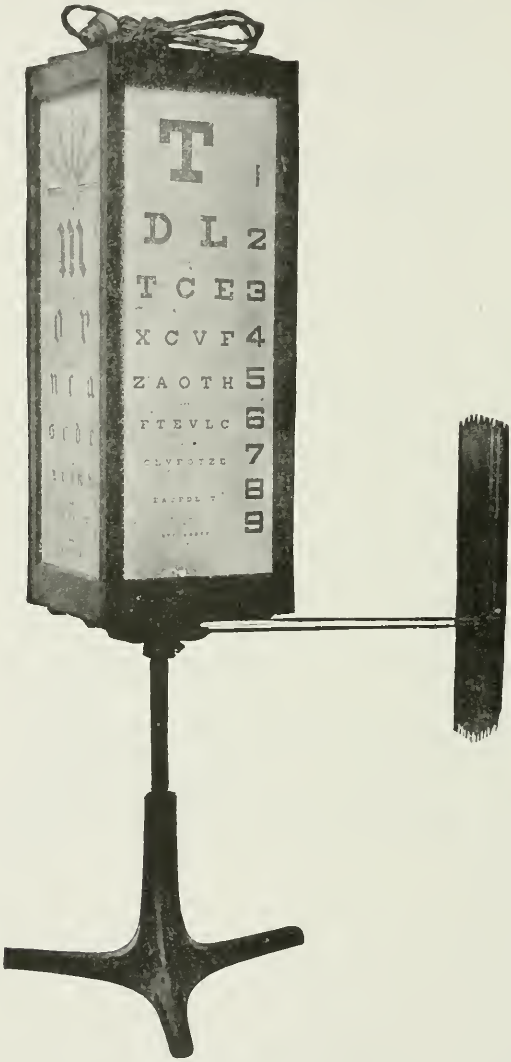
Black's Testing Cabinet No. 1.

this Black devised a test chart with the characters placed upon translucent glass which is illuminated by electricity and maintained practically at a constant intensity of surface brightness and contrast with the letters.

It happens that candidates sometimes memorize the test cards upon which the letters from 6/LX to 6/V vision are printed and then pass on the information to others. They are consequently able to pass the visual acuity test with actual vision below the required standard. To overcome this, test cards are made up with one line of letters upon each card with three cards for each size of letters used.

EDRIDGE-GREEN'S THEORY OF VISION AND COLOR-VISION.

Before taking up the various tests for color-blindness Edridge-Green's theory of color vision will be briefly described as it is merely



Black's Testing Cabinet No. 2.

mentioned under **Theories of color-vision,** page 2494, Vol. IV of this *Encyclopedia*, as "based upon electro-physiological phenomena, and it is quite certain at present that the actual retinal processes are of a

photo-chemical character." (The Editor states a more complete treatment of this subject will appear in a later volume.) This is done for the purpose of making more clearly understood some of the criticisms as to the adequacy of the various tests for color-blindness.

Edridge-Green's theory of vision (Hunterian Lectures, *Ophth. Rev.*, Sept., 1914) is: The cones are the terminal perceptive visual organs. The rods are not perceptive elements, but are concerned with the formation and distribution of the visual purple. Vision takes place by stimulation of the cones through the photo-chemical decomposition, by light, of the liquid surrounding them which is sensitized by the visual purple. The character of the stimulus differs according to the wave length of the light causing it. In the excitation itself we have the physiological basis of the sensation of light, and in the quality, or wave length, of the excitation of the physiological basis for the sensation of color. The impulse being conveyed along the optic nerve to the brain, stimulates the visual center, causing a sensation of light, and then passing on to the color-perceiving center, causes a sensation of color. But though the impulses vary in character according to the wave length of the light causing them, the retino-cerebral apparatus is not able to discriminate between the character of adjacent stimuli, not being sufficiently developed for the purpose. At most, seven distinct colors are seen by some; others see in proportion to the development of their color-perceiving centers, only six, five, four, three, or two. This constitutes color-blindness, the person seeing only two or three colors instead of the normal six, putting colors together as alike which are seen by the normal sighted to be different. In the degree of color-blindness just preceding total, only the colors at the extremes of the spectrum are recognized as different, the remainder of the spectrum appearing gray. "Though my own opinion is that the ordinary form of congenital color-blindness is caused by a defective development of the portion of the brain which has the function of the perception of color, we must not exclude any portion of the retino-cerebral apparatus, defect of which would have exactly the same result. It will be noticed that the theory really consists of two parts, one concerned with the retina and the other with the whole retino-cerebral apparatus."

Other theories of color-vision are mentioned or described in Vol. IV of this *Encyclopedia*, as follows: **Franklin's theory,** page 2395; **Oliver's correlative theory,** page 2410; **Ebbinghaus's theory,** page 2410; **Helmholtz's theory,** pages 2410 and 2426; **Hering's theory,** pages 2410 and 2430; **Young's theory,** pages 2414 and 2426; **Pryer's theory,** pages 2414 and 2430; **Parinaud's theory,** page 2431; **von**

Kries's theory, page 2431; **Koenig's theory,** page 2431. No two of these agree and not one is entirely satisfactory.

The following *tests for color blindness* (arranged alphabetically), have at various times been used for the purposes described in this section. Most of them (as well as others not tabulated here) have already been discussed in this *Encyclopedia*, especially under **Examination of the eye** and **Color-sense and color-blindness.** However, it seems proper to speak again of certain of these here, with a reference to the precise volume and page of this *Encyclopedia,* where additional information regarding them and other tests may be found.

Abney's color patch apparatus (described on page 2408, Vol. IV, of this *Encyclopedia*): "A very fair idea of the amount of deficiency in the red and green sensations is given by noting the names given to the colors at various parts of the spectrum."

Abney's test by water-color washes. Edridge-Green mentions this test in his book on "*Color Blindness*" (*International Scientific Series,* 1891). It is simply a test for those who are not color ignorant. Water-color paints are washed upon drawing paper and when dry the candidate is asked to name the hue of the wash. The author states: "By mastering the principles which underlie the trichromatic theory it is easy to make tests by colored materials other than wools."

Abney's test by colored discs. "A test which can be applied qualitatively as well as quantitatively is that of rotating color discs of red and green, with black and white sectors behind the smaller pair. The examinee may make a match in daylight looking through a chromatic cell containing chromate of potash in solution. The angle of the red or green is altered until the two give a yellow which matches in hue the outside disc . . . when a match is made, the angles of the discs should be noted and a rough estimate can be made by a comparison of the normal equation with that of the examinee. If the red sector is the greater the latter will be incompletely red-blind; and if the green sector is the greater (compared with the normal) there is incomplete green-blindness."

Abney's dot test. Different colors are thrown on a small white disc about ⅛ inch in diameter, mounted on black velvet. The examinee, standing 12 to 20 feet away, is required to name the color. By diminishing the angle subtended by a patch of color, it becomes colorless. As one of the color sensations to the color-blind is less than to normal vision, it follows that the small patch may fail to show the color to the color-blind when it is visible to the normal eye.

Adler's color crayons (mentioned in Vol. IV, pages 2388, 2442, of this *Encyclopedia*). An assortment of colored crayons is used in-

stead of the wools of Holmgren's test. The principle of the test is the same, however. The candidate is asked to select from a large number of crayons all the blues, greens, and so on. These choices are utilized to mark a paper with, and so a permanent record is obtained.

Armaignac's modification of Holmgren's wool test. Forty-three strands of wool of different colors and shades are twisted into a cord and formed into a tassel. The candidate examined is first shown the end of the tassel, where merely the end of a strand of each color appears, and asked to name the colors; if he is not successful the cord is unwound for about a centimeter, showing a longer strand of each color. With this cord, also, candidates are required to compare and match colors and shades.

Badal's color cylinders (mentioned in Vol. IV, pages 2388 and 2457, of this *Encyclopedia*).

Bekess' lantern (described in Vol. IV, page 2370, of this *Encyclopedia*).

Benham's top (described in Vol. II, page 931, of this *Encyclopedia*).

Browning's pocket spectroscope (described in Vol. IV, page 2460, of this *Encyclopedia*).

Burch's color test (described on page 2487 of this *Encyclopedia*).

Burton's telechrome (described on page 2462 of this *Encyclopedia*).

Carter's test (described on page 2465 of this *Encyclopedia*).

Chibret's chromatoptometer (described in Vol. III, page 2197, and mentioned on pages 2382 and 2443 of this *Encyclopedia*).

Cohn's chromaskiopticon (mentioned in Vol IV, page 2443, of this *Encyclopedia*). An apparatus for detecting color defects by means of the complementary colors of shadows. "If we hold before a lamp a piece of colored glass, and allow the light thus colored to fall upon a white screen, this will then appear colored. Now holding a pencil, for instance, before the screen, we will have a shadow cast on the colored surface. This shadow will, to the normal eye, appear of a complementary color of the glass before the lamp; whilst to the color-blind the shadow will appear colorless, or black or gray" (Jeffries). The chromaskiopticon of Cohn uses oil lamps with seven colored glasses: red, orange, yellow, bright-green, dark-green, violet and blue, and a piece of wood the size of a finger to produce the shadow.

Cohn's embroidery patterns (mentioned in Vol. IV, pages 2443 and 2457, of this *Encyclopedia*), in which colored worsted letters are worked on a background of a color with which they are usually confounded by the color-blind.

Colored shadow test (described in Vol. IV, page 2459, of this *Encyclopedia*). (See *Cohn's chromaskiopticon* above.)

Daae's color table (described in Vol. IV, pages 2456 and 2481, of this *Encyclopedia*).

Donders' color chart (described in Vol. IV, page 2387, of this *Encyclopedia*). A method of quantitatively determining color perception with reflected light. Discs of colored paper, 1, 2, 5 or more millimeters, are each separately glued to small pieces of black velvet, also, in like manner, pieces from the white, red and green signal flags. These little pieces of velvet are placed against a larger piece of velvet 1 meter square. The candidate with perfect color-sense (ametropia corrected) should recognize the color of the 1 millimeter disc at 5 meters.

Donders' lantern (described in Vol. IV, pages 2381 and 2461, of this *Encyclopedia*).

Donders' pseudo-ischromatic patterns (described in Vol. IV, page 2458, of this *Encyclopedia*).

Donders' wools (mentioned in Vol. IV, pages 2443, 2457, 2466, of this *Encyclopedia*). On a number of little discs of wood a color is wound; another color, which the color-blind can not distinguish from the first, is so wound over it as to form rays of a star. A color-blind person is detected in not being able to select discs which present to the normal eye contrasting colors.

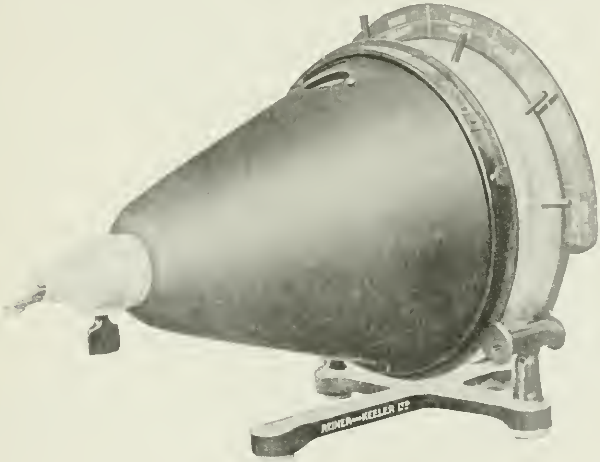
Dor's test. Like Donders' test this one is based on the fact that when a person approaches a small colored object, the normal eye detects the color but little later than the light. Dor made six chromatic plates (lithographs) each made up of seven different colored discs of different sizes on the black background; the colors are yellow, red, orange, green, blue, violet and purple. The distance at which the person tested observes and names the color is compared with the distance at which a normal person observes a disc of the same size and color. Donders' formula may be simplified to $K = \frac{d}{D}$ in which d = actual distance, D = distance at which normal eye perceives color (the m in Donders' formula being constant). Three of Dor's plates are for daylight tests and three for artificial light.

Dunn's color test (described in Vol IV, page 2487, of this *Encyclopedia*).

Edridge-Green's bead test (described and illustrated in Vol. IV, on page 2409, of this *Encyclopedia*).

Edridge-Green's classification test (erroneously described under "bead test" on page 2458 of this *Encyclopedia*) is regarded as only supplementary to his lantern test and is made up of four test colors and 180 confusion colors, 150 colored wools, ten skeins of silk, ten small

squares of colored cardboard, and ten small squares of colored glass. The whole series of colors is represented, both the simple and modified units. In addition there are a large number of colors which have been chosen by color-blind persons as matching the test colors. The test colors are orange, violet, red and blue-green, labelled I, II, III and IV, respectively. The colors are chosen with the view of presenting as much difficulty as possible to the color-blind, and as little as possible to the normal-sighted. In addition to choosing those colors for tests which are particularly liable to be mistaken for other colors by the color-blind, colored materials of different kinds are used—wools, silks, glass and cards so as to force the color-blind to judge by color, and not by shade of luminosity.



Edridge-Green's New Model Lantern.

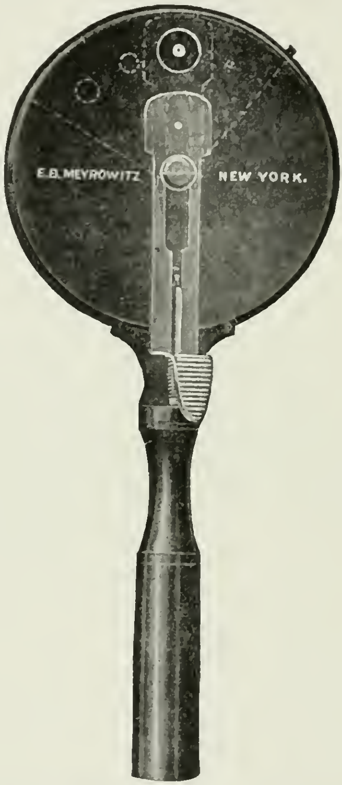
Edridge-Green's pocket test consists of nineteen cards, on nine of which are 112 single threads of wool, and fourteen pieces of twisted silk, similar to those in the classification test. These are numbered consecutively, with the exception of the first thread of the first four cards, and the last thread of the next four cards. The end threads of the first four cards, I to IV, form the tests; they are orange, violet, red and blue-green. There are also cards on which red, orange, green, blue, violet and purple, and gray, respectively, are to be found. There are also two special cards marked "Without Red" and two special cards marked "Without Green."

Edridge-Green's color perception spectrometer (described and illustrated in Vol. IV, page 2412, of this *Encyclopedia*).

Edridge-Green's color vision spectroscope (described in Vol. IV, page 2493, of this *Encyclopedia*).

Edridge-Green's lantern (mentioned in Vol. IV, pages 2380, 2447, 2457; described and illustrated on page 2410 of this *Encyclopedia*).

English Board of Trade lantern test. Consists of a paraffin lantern showing red, green and white which shows one or two small lights simultaneously; these are reflected from a mirror without means of regulating the intensity of the illumination.



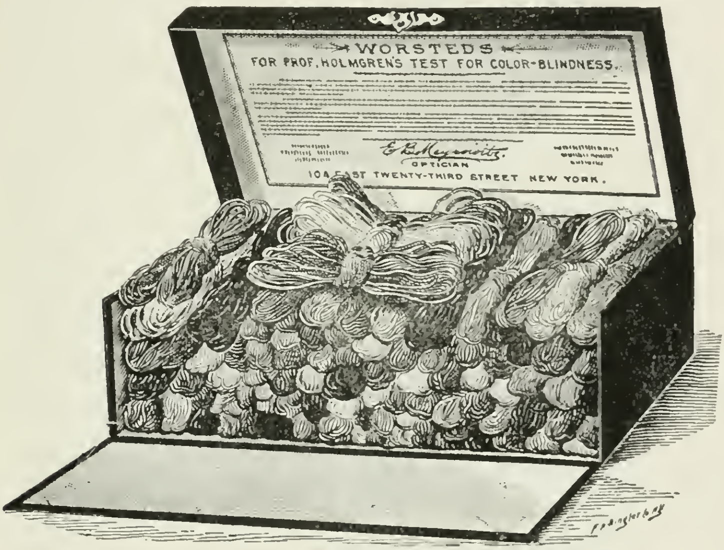
Fridenberg's Test for Central Color Perception.

English Board of Trade modification of the Holmgren worsted test consists of *(a)* substituting a dark-brown skein for the third (deep-red) test skein at present in use; *(b)* by dividing the skeins into specified groups, one group for each test skein, and requiring the candidate to divide each group into two parts, those which resemble in color the test skein and those which do not.

Favre's test consists merely in naming the color of certain objects, but Jeffries states that it involves the same principle as the tests of

Donders and Dor, i. e., the distance at which the color is observed and named.

Fridenberg's test for central color perception. This instrument resembles an ophthalmoscope, but instead of lenses it is supplied with a series of colored discs and a diaphragm with various sized openings. The color in situ is exposed by drawing down the slide which is spring actuated, and terminates the exposure instantaneously when released and before patient can bring another part of retina into position.



Holmgren Wool Test.

Heidelberg color book (mentioned in Vol. IV, page 2443, of this *Encyclopedia*).

Hierlinger's tables (mentioned in Vol. IV, page 2443, of this *Encyclopedia*).

Hirschberg's double spectroscope (mentioned in Vol. IV, page 2443, of this *Encyclopedia*), consists of two spectra shown one above the other in reversed order; movable slits allow monochromatic portions of each spectrum to be shown. The candidate being required to match the color on the lower spectrum with that shown through the slit of the upper.

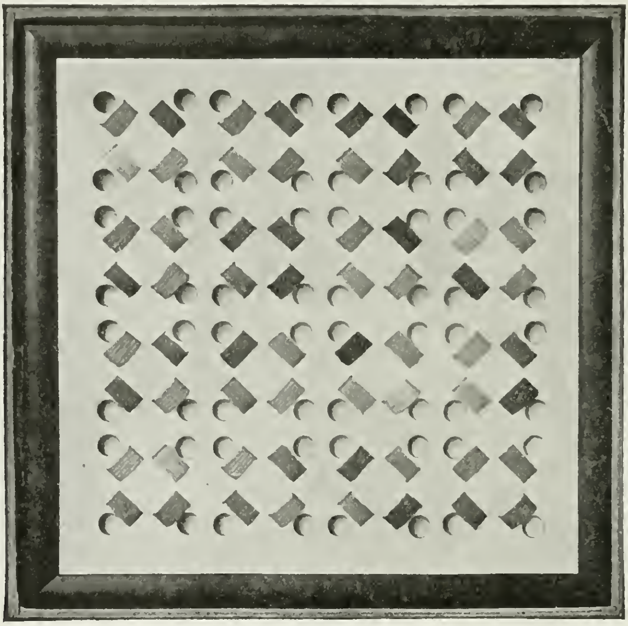
Holmgren's worsteds (mentioned in Vol. IV, pages 2442, 2447; described on page 2448 of this *Encyclopedia*).

Holmgren's lantern is provided with three shades, each, of red and

green glass that can be turned before a flame. It was chiefly used to convince the officials of a railroad of the actual presence and danger of color-blindness.

Jeaffreson's modification of Holmgren's test (described in Vol. IV, page 2455, of this *Encyclopedia*).

Jennings' self-recording modification of Holmgren's test is fully described and pictured on page 4676, Vol. IV, of this *Encyclopedia*.



Jennings' Self-recording Test for the Detection of Color-Blindness.

Kolbe's truncated cones (mentioned in Vol. IV, page 2443, of this *Encyclopedia*) consists of two obtuse cones, placed apex to apex and rotating on a vertical axis. The side triangles are covered with various colored paper, so that one triangle in the cone with its base upward shows one color, for example, blue; the corresponding triangle in the other cone shows a contrasting color, e. g., red. By rotation mixed colors may be produced. The apparatus is covered so that shutters can be raised to show part of the apparatus at a time. The person tested stands at 1 meter from the apparatus, and as the cones are rotated and a shutter is raised, he is asked to pick out the colors corresponding to those shown in a color table or a collection of colored wools.

Lip's color triangle (mentioned in Vol. IV, pages 2443, 2490, of this *Encyclopedia*).

Luminosity curves (described and illustrated in Vol. IV, page 2434, of this *Encyclopedia*).

Magnus's modification of Holmgren's test requires the candidate to pick from bundles of colored worsteds those which match the colors of the solar spectrum shown at the same time.

Magnus's tables (mentioned in Vol. IV, page 2443, of this *Encyclopedia*) consist of nine rows of colored cards in brown, purple, red, orange, yellow, green, blue, violet, black (or gray), each in four different shades. With these tables a portfolio of 72 different colors in miscellaneous arrangement is used, each color in the tables appearing twice in this portfolio. The miscellaneous colors are shown the person tested and he is required to sort out quickly the same color as the one shown him on the tables; if he is successful he may then be asked to sort out similar colors and different shades of the color indicated.

The test may be varied by employing colored wools instead of the color tables.

Mauthner's powders (described in Vol. IV, page 2457, of this *Encyclopedia*).

Maxwell's color box (described in Vol. IV, page 2431, of this *Encyclopedia*).

Maxwell's revolving discs (mentioned in Vol. IV, page 2490) is a test of the chromatic sense by means of colored discs revolving on a top, so arranged that the various colors can be combined in any proportion.

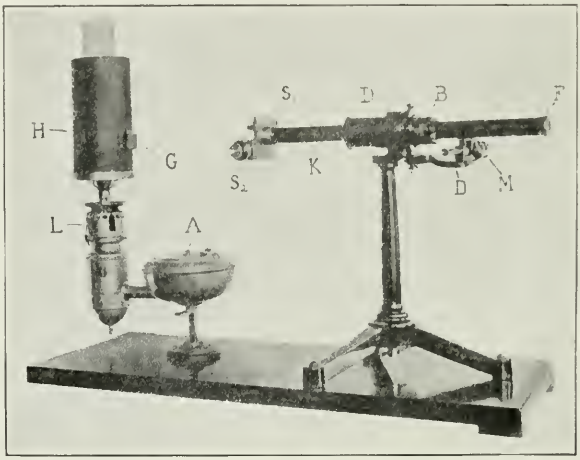
Meyer's tissue-paper test (described in Vol. IV, page 2459, of this *Encyclopedia*).

Middleton's lamp (described in Vol. IV, page 2488, of this *Encyclopedia*).

Nagel's anomaloscope (mentioned in Vol. IV, page 2442, of this *Encyclopedia*) is an instrument for making the Rayleigh test. It serves, as the name suggests, not only to unmask color-blindness (dichromatism), but also to detect anomalous trichromatism. The anomaloscope consists essentially of a telescope, in which the examinee sees a small circular field. The field is divided into two by a horizontal line. The lower half obtains its light from a prism which is so adjusted that only yellow (sodium light) illuminates it. This is done by a screw, which is called for convenience, the "yellow screw." If the scale attached to the screw stands at zero, the field is quite dark, 88 indicates its maximum brilliancy. It is therefore possible by turning the yellow screw to vary the brightness of the lower field between

the widest limits. The color, however (sodium yellow), remains constantly the same.

The upper half of the circular field is simultaneously lighted by two prisms, one of which is adjusted to furnish green light (thallium green), the other red light (lithium red). In this case, also, slits are placed behind the prisms which can be adjusted at will either fully opened or



Nagel's Anomaloscope, for Testing Color-Vision.

K, collimator tube; F, eyepiece tube; D, prism; M and lower D, screws to control position of eyepiece tube; B, diaphragm to alter size of visual field; A, holder for alcohol; L, mantle lamp using alcohol vapor; H, asbestos chimney surrounding glass chimney of lamp; G, ground glass plate, source of illumination for anomaloscope; S_1, right-hand screw (G_1 of Fig. 9), controlling width of upper slit and lower half of field as seen at the eyepiece F. This screw regulates the brightness of the pure yellow half of the field. S_2, left-hand screw, (G_2 of Fig. 9), controlling the width of the two coupled slits and the upper half of the field as seen at the eyepiece. Through one slit light is transmitted through the prism, which, when seen at the eyepiece, corresponds to the lithium red; through the other slit comes the thallium green. By moving the screw, S_2, the upper half of the field is illuminated by a proportional amount of the red-green mixture, from a red to a yellow and then to a green.

quite shut. But it is only possible to alter the two slits simultaneously, and their motions are complementary in the sense that as one opens the other shuts in an equal degree.

In this way it is possible to modify the light mixture as desired. Any mixture of red or green may be made or either color entirely cut out. The slits are adjusted by a screw which is called the "red-green screw." The milled head of the screw is graduated from 0 to 88. If the pointer stands at 0 the field is pure spectral green, if it is turned red is intro-

duced. The more red is added, the more colorless the green, until at a certain spot (fifty-eight on the scale) the upper half of the field becomes a colorless yellow, neither green nor red. As the screw is turned the upper field takes on a red tone, which becomes more marked, until ultimately all the green is shut out and the field is a pure spectral red.

Nagel's plates consist of a set of cards, each bearing a series of little colored discs arranged in a ring. In some rings the discs are all one color, but of slightly different shades; in others the discs are of two or three different colors (confusion colors). By making the patient state which rings are monochromatic, and then make him pick out in the dichromatic or trichromatic rings all the discs that are one special color, one can readily ascertain whether he is color-blind and what sort of color-blindness he has.

F. Vierling (*Arch. f. Aug.*, 77, p. 242, 1915) has modified the apparatus of color equalization of Nagel by exchanging the colored glasses by gelatine leaves made with finer distinction of the required shades of color. The apparatus does not supplant the anomaloscope, but it has detected minor anomalies in patients who passed the tests with Nagel's or Stilling's plates.

Oliver's color-sense measure (described in Vol. IV, pages 2461 and 2469, of this *Encyclopedia*).

Oliver's worsted test is intended as a ready, and yet strictly scientific clinical test, which can be used for short distances. In this set there are three series of colors:

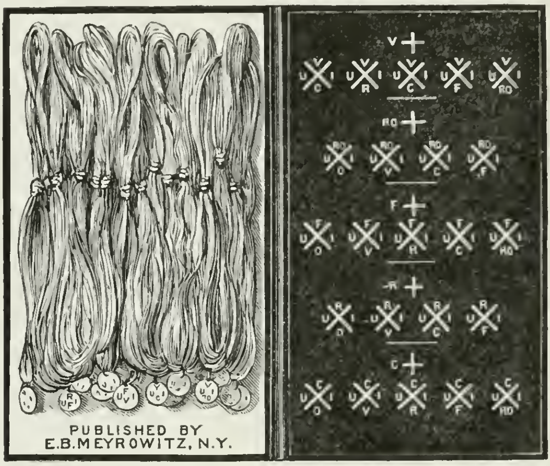
First. Five principal test skeins of large size; these are pure colors. Latin names have been employed to represent them. Pure green has been styled "Viridis;" pure red has been termed "Ruber;" pure blue, "Cœrulem;" purė yellow, "Flavus," and rose, "Rosa." The colors of these skeins are of equal intensities.

Second. Five small, pure match skeins. Each skein is a pure shade of one of the large skeins; each skein has a bangle containing an inscription which indicates that the attached skein is a shade of one of the principal test skeins fastened to it. Thus for example, in the first series V O I U indicates that the color is a pure green, one shade darker than the larger sample shade of green, the initial letter U designating the word "Umbra," the Latin name for shade.

Third. Eighteen small confusion skeins, each of which is composed of equal percentages of two of the pure match skeins, the component colors being designated by the initial letters of the colors contained therein, the upper initial giving the preponderant color of the two.

Thus, for example, V R U I represents a confusion color composed of green and red, the first color being preponderant in the proportion of two to one; while R V U I is two to one in excess of the red. In this way every color is correlated, thus bringing the match skeins series, both pure and confusion, to one degree of color intensity.

For examination, diffuse daylight is necessary. A square of black muslin is placed upon a table situated at about one meter's distance away from the candidate's eye. The eyes of the subject are to be tried separately. The five large test skeins are separated from the twenty-

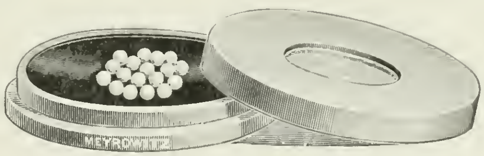


Oliver's Wool Test.

three match skeins. One of the large test skeins (preferably the green one) is handed to the candidate, and he is requested to select the nearest matches to this skein from the pile of wools, and to lay them alongside of the test wool in the order of their matching. If necessary, the examiner should go through the procedure and show the candidate what is wanted, taking care so to disarrange his choice that it will be impossible for the candidate to gain knowledge from the selection. The letterings upon the tags of the chosen wools are then to be registered in the order of the color choice, upon a properly arranged blank. This finished, the wools are to be replaced among the general mass of wools and the same method of selection continued with the rose, the red, the blue and the yellow series. The procedure does not, as a rule, consume more than a few minutes' time for each candidate. In fact, if care be

taken to prevent inter-communication, several candidates may be examined with different sets at the same time.

Oliver's modification of Abney's pellet test for detecting color scotomata consists of a wooden disc, upon the upper surface of which definitely-tinted, spherical pellets are loosely laid, the whole being covered with a transparent lid. The disc which has been painted dead black and which is ten centimeters in diameter, is constructed like a plano-concave lens, with its upper concave surface made equal to the curvature seen in a minus spherical lens of four diopters strength. The lid, which is of clear plane glass, surrounded by a beveled rim of blackened metal, is hinged upon the disc base and is fixed in position by a metallic push spring-clip. The pellets, each of which is four millimeters in diameter, are composed of ivory, and are definitely gauged in their relative tintings to equal degrees of color saturation.



The Oliver-Abney Pellet Test.

A pair of ingeniously contrived forceps so fashioned that each pellet is most easily held in position when once grasped, accompanies each box.

The plan of procedure is to employ but one eye at a time, taking care that the unused one is excluded from participation in the test. The apparatus, placed upon some broad black surface such as a large dead black table cloth, is then brought into view.

The green pellet is removed from the rest of the colored pellets in the color tray and laid upon the cloth alongside of the forceps. The color tray with the remaining pellets is left open and exposed. The patient is shown the separated pellet and the forceps. Nothing is said to him in regard to the name of the tint or the color. He is then requested to pick up the pellet with the forceps and hold it in the position before him at which it seems the brightest and the plainest. If he holds it eccentrically or turns his head to one side in order better to see the pellet, his defect will become quite evident. He is then asked to hold his head in such a position that his exposed eye is situated at some forty to fifty centimeters distance directly above the color tray. While in this situation he is made to drop the pellet among its

fellows in the color tray. The moment that the pellet has been placed in the tray the box is given a slight twist so that the pellets will be made to assume new relative positions. This done, the patient is requested to select the pellet from among its companions. If he has a central scotoma for green of but a couple of degrees in diameter when the test tray is held in this position, it will be almost impossible for him to regain the green color pellet—thus again objectively showing the central field defect for the perception of green and at the same time objectively proving its existence. The test is to be repeated with the fellow eye, and if desired, with the red, the blue, and the yellow series of pellets.

Pfluger's tissue paper test is a modification of Meyer's (described in Vol. IV, page 2459, of this *Encyclopedia*).

Pfluger's color book (mentioned in Vol. IV, page 2443, of this *Encyclopedia*) consists of black letters printed on colored paper and covered with tissue paper, the letters appearing in the color complementary to the background.

Polariscope test (mentioned in Vol. IV, page 2460, of this *Encyclopedia*). See **Chromatophotoptometer of Chibret** and **Tomlinson's tests.**

Ragona Scina contrast test (described in Vol. IV, page 2459, of this *Encyclopedia*).

Ramsay's spectroscope (described in Vol. IV, page 2469, of this *Encyclopedia*).

Rayleigh's matching test (mentioned in Vol. IV, page 2436, of this *Encyclopedia*).

Rayleigh's color mixing apparatus necessitates matching the sodium D light of the spectrum by a mitxure of red and green light. There are different instruments used for the purpose. (See Nagel's anomaloscope and Williams' spectroscope.)

Reuss's color tables (mentioned in Vol. IV, pages 2443, 2457, 2485, of this *Encyclopedia*). Von Reuss has arranged 32 cards, each with ten strands of colored wool fastened on, arranged partly in isochromatic groups showing only one shade, partly isochromatic, showing several nuances, and partly pseudo-isochromatic. The person tested is required to sort out all the isochromatic cards. (Schenke.)

Roberts' color tables (mentioned in Vol. IV, page 2443, of this *Encyclopedia*).

Rose's polariscope (mentioned in Vol. IV, page 2443, of this *Encyclopedia*). Rose utilized colors shown by a quartz plate in polarized light. The tube of his polariscope contained a Nicol prism, a rectangu-

lar diaphragm, a double refracting prism, quartz plate (5 mm. thick), a second Nicol prism.

The person looking into this polariscope sees two images of contrasting colors, which can be modified by rotating the second Nicol prism. The rotation of the Nicol prism modifies their intensity only. A normal person cannot make the two colors equivalent, but a person if color-blind will find on turning the prism that in a certain position the two complementary colors are equal, which shows at once what colors are confounded by him. The Rose polariscope is expensive and is not much used.

Rostschewski's modification of Holmgren's test consists of small balls of wool, diameter 5 to 7 mm., using 136 shades, the classic Holmgren assortment. Small pieces of metal of gray color are used to handle and arrange the balls. Three test balls are used—green, purple and red—and the candidate requested to sort out the balls of similar colors. A simpler assortment of balls for the green test alone can be used as a preliminary test.

Rumble's test (described in Vol. IV, page 2456, of this *Encyclopedia*).

Sanrineau's test (described in Vol. IV, page 2489, of this *Encyclopedia*).

Schenke's yarn covered spools (mentioned in Vol. IV, pages 2443, 2457, of this *Encyclopedia*). Schenke uses a collection of 40 to 50 small rods covered with colored wools, which are easily arranged in a wooden ring, from which they may be easily withdrawn, so placed that they form a star. The test colors are chosen from the two vertical radii, and the person tested required to take out all the rods showing similar, not identical, colors: the test is continued until the star appears to him to consist of only one color in various shades. The manner in which the person performs this test, what colors he chooses first, and which puzzle him most, indicates the correctness of his color vision.

Schirmer's test. Cohn states that this test is based on the principle of successive contrast, the fact that with the normal person certain colors give certain definite after-images, e. g., a yellow piece of paper looked at steadily for a minute leaves an after-image of a blue spot of the same size. The test is begun with yellow, the other colors are shown in succession, and the candidate asked to name both the original color and that of the after-image, the replies being noted in order.

Seebeck's test. In this test about 20 pieces of colored paper are used, the candidate sorting these and putting together those which to him look alike.

Simultaneous contrast tests. See Cassel's, Cohn's, Pfluger's, Ragona, Scina and Waldstein's tests.

Snellen's optotype. Snellen gives a description of his color tests in the English edition of his book on *Test Types.*

Snydacker's color squares (described in Vol. IV, page 2474, of this *Encyclopedia*).

Stilling's chromatoskiometer (mentioned in Vol. IV, page 2443, of this *Encyclopedia*).

Stilling's simultaneous contrast test (described in Vol. IV, page 2459, of this *Encyclopedia*).

Stilling's plates. These are partially described in Vol. IV, pages 2383, 2457, 2485, of this *Encyclopedia*, and are ten in number, each plate containing four squares filled with small colored spots, among which other spots in a confusion color are so arranged as to represent a letter or figure.

Stilling was aided in the preparation of these plates by a red-green blind painter and a blue-yellow blind teacher and in this way he built up two classes of interchangeable colors. (1) Fiery-red, interchangeable with dark-yellow. Intense green, interchangeable with dull-loam color. Faint-rose, interchangeable with bright-gray. Faint blue-green, interchangeable with bright-gray. (2) Fiery-red, interchangeable with intense gold-yellow. Greenish-yellow, interchangeable with faint bright-blue. The last two, interchangeable with bright-gray. Green, interchangeable with blue. These two, interchangeable with dark-gray.

In using this test, "the test plate is held in a good light and the candidate required to distinguish the letters or figures. An important feature of this test is that there is no inquiry as to color, but only as to letters and figures." The test is made at 20 feet distance.

Spectroscopic tests. See Edridge-Green's, Nagel's, Rayleigh's, Ramsay's and Williams' tests.

Successive contrast tests (mentioned in Vol. IV, page 2443, of this *Encyclopedia*). The complementary color appears after looking steadily at a colored surface on a gray back-ground for a time, if the colored object is quickly removed.

Thomson's lantern (mentioned in Vol. IV, page 2380, of this *Encyclopedia*). It consists of an asbestos chimney which can be placed on a kerosene lamp in universal use on railroads, or over an Argand burner or other gas light, electric lamp or spring candle stick.

There are two discs three and one-half inches in diameter, each containing seven openings which carry the colors, which revolve over each other so the colors may be seen separately through the opening at which they are presented, or be superimposed.

The openings in the discs where the colors are shown are one-half inch and one-twelfth inch in diameter, and are made of the size to simulate signals at different distances. Taking Donders' formula for measurement of color perception, the small opening of one-twelfth inch, when placed in front of a color, is equal to normal color vision at thirty-two feet. The one-half inch opening is equal to normal vision at 200 feet and for practical purposes the one-half inch opening at twenty feet is equal to the ordinary five-inch semaphore light at one-half mile.

The lower disc contains the standard colors used as signals on the railroads: red, blue-green, blue of the inspector's light, and yellow. This disc is known as the examination in chief.

The colors have been carefully selected and are identical with the standards used on the railroad when shown in the lantern. These colors are designated by numbers, 1 to 7.

The upper disc contains the confusion colors, and the small opening of one-twelfth inch which is used as a quantitative measure of color perception. This is known as the cross-examination and its colors are designated by letters of the alphabet—A, B, C, etc.

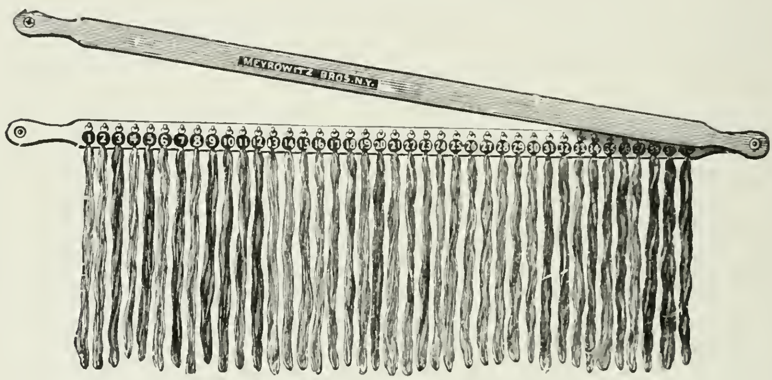
The colors of this disc are pink, yellow-green, cobalt, deep London smoke, and gray-ground glass and are the most important in detecting the different types of color-blindness, and especially those varieties that are not perfectly determined by the wool test. For example, the three colors, pink, yellow-green, and gray-ground glass are the typical neutral colors of the color-blind and represent the confusion colors of the wool test. The pink, which to the normal eye appears light-red, is composed by the spectroscope of pure red and blue. This cannot be imitated in glass, so it is made of a piece of colored gelatin and placed between two layers of glass. If this color is regarded through a piece of peacock-blue glass, cutting off the red it appears blue. The normal eye sees it as light-red, the red-blind man, having his red sensation defective, sees only the blue and as these three colors, pink, yellow-green and gray, are the color-blind man's white, so the pink may be mistaken for white; the same holds good with yellow-green or gray ground glass, which may be mistaken for white, red, or green. It will be found in the practical examination of one who has a defect in his color sensation that these three colors are invariably designated as the same color; the only distinction he makes is that they are different shades of the same color, while to the normal eye they are three distinct colors.

The London smoke is used to reduce the intensity of the color and for practical purposes simulates the changes that take place in the atmosphere, rain, fog, etc. The cobalt transmits both red and blue and

is also a good test and at the same time, when used with other colors, makes valuable combinations.

By being able to superimpose the colors one over the other one is able to get not only a considerable variety of different colors, but many shades of the same color, for example, seven shades of red, ranging from an exceedingly dark-red color that might be represented by a lamp burning very low, up to a very light pink. These can all be shown in rapid succession.

The addition of the corrugated lens in the present lantern is of great improvement. It overcomes the former difficulties by giving a uniform opening and at the same time does not reduce the intensity and saturation of the color, and secondly the corrugations of the glass being



Thomson's Stick of Colored Wools.

very small, is practically a miniature semaphore light, and acts precisely the same at the distance we use it, as the railroad semaphore.

In the lantern only one color at a time is presented for examination, and in this it differs from some other lanterns which are now in use. The colors are named or their indication specified.

Thomson's test with cobalt blue glass consists in making a patient look through a good cobalt glass at a light which to an eye accommodated for the distance of the light or a nearer point will appear red with a blue halo around it, whilst to an eye accommodated to a distance greater than that of the light it will appear blue with a red halo around it. The red-blind or green-blind will see the blue very well, but the red will betray him soon by its absence.

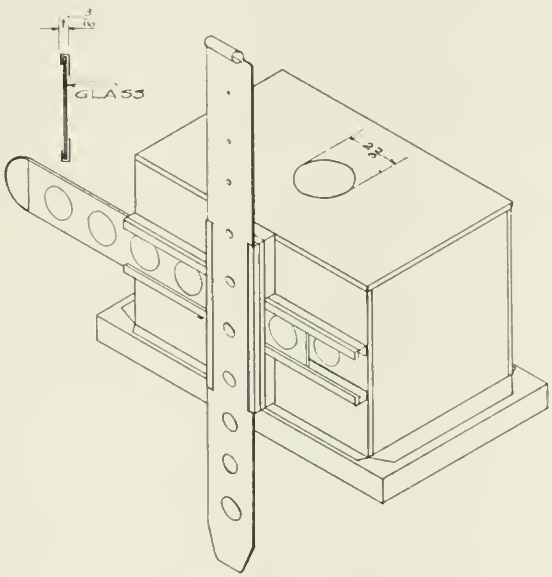
Thomson's wool stick (described in Vol. IV, pages 2453 and 2480, of this *Encyclopedia*).

Thomson's wools (described in Vol. IV, page 2454, of this *Encyclopedia*).

Tomlinson's polariscope (described in Vol. IV, page 2470, of this *Encyclopedia*).

Verhœff's test for color-vision (described on page 4678 of this *Encyclopedia.*)

Waldstein's chromatoscope test is applied by holding before a lamp a piece of colored glass, and allowing the light thus colored to fall upon a white screen, which will then appear colored. Now, holding a pencil, for instance, before the screen, one notices a shadow cast on the colored surface. This shadow will to the normal eye appear of the comple-



Welsh's Lantern.

mentary color of the glass before the lamp; while to the color-blind the shadow will appear colorless, black or gray.

Welsh's lantern (mentioned in Vol. IV, page 2457, of this *Encyclopedia*). Welsh had for his lantern test a "caboose" end built in a recess of his office. He used four lanterns, one on the top, one at each side, and one on the platform of this caboose end. These lanterns were of the same type as those in use on the rear ends of trains; they were equipped with colored glass and with electric lights. The lights are flashed on quickly and the candidate placed at a distance of 30 to 40 feet, and asked to name the light flashed. The colors shown were red, green and white.

Welsh's latest model consists of a box 11 inches long, 7 inches wide and 7 inches high, fastened on a wooden base. The apertures through

which the color is visible vary in size from 1/8 of an inch to an inch in diameter. The glass is arranged in a second slide in sections 1½ by 2 inches, in front of which there is an opening 1⅛ inches. Slide No. 1 passes over slide No. 2 in a vertical and horizontal plane. The top of the box is open to admit an electric light and the bottom arranged with an opening in which to place an oil light or pot similar to those used on passenger coaches. The applicant is taken into a dark room and the colors are flashed. The lantern slides consist of white, red, green and blue glass, which are arranged in front of the light. Over this slide is run a second slide with apertures varying in size as the dimensions in the lantern show. With a defective the findings are always confirmed by a yarn test.

Williams' lantern (mentioned in Vol. IV, page 2380, described and illustrated on page 2410, of this *Encyclopedia*).

Williams' spectroscope consists of an addition to the Ives duplex diffraction spectroscope, which allows monochromatic areas of the spectrum to be observed and by an ingenious adaptation the red-green junction in the spectrum may be matched with a constant yellow introduced by means of a total reflecting prism and a yellow glass wedge.

Wilson's test consists of little bundles of colored worsteds, which the applicant sorts out and places together those seeming alike. The principle being one of comparison, the applicant not being obliged to name any colors.

Woinow's revolving disk shows an inner circle of which one-half is black and the other half white. It appears to be gray when revolving. Three rings outside of this are composed of equal parts of two of the three primary colors, red, green, violet. To a person blind to the color not represented in one of the rings, this ring will appear gray. Later he may modify his disk, as he accepts four primary colors. The inner ring is now to be red and violet (or blue); the outer, green and violet (or blue); the third is left out. If the outer appears gray like the center we have green-blindness; if the inner, red-blindness; if both, red-green-blindness.

Zeeman and Weve color mixing apparatus (mentioned on page 2444 of this *Encyclopedia*). Zeeman and Weve use an ordinary projection apparatus and a combination of lenses, and mirrors to throw the colors on a field in such a way as to divide the spectrum into two parts; each half can be sub-divided into two or three parts by a small lever.

In the upper half the light is made yellow with natrium; in the lower half there are two parts, one green and one red; the test is to make a yellow similar to the upper yellow by combining red and green.

The apparatus is designed also to test effects of different intensities and the wave lengths of the spectrum colors used.

VALUE OF OFFICE TESTS.

The value of a test of visual acuity by means of characters which subtend a five minute angle exposed at 5 to 6 meters distance has been questioned by many prominent ophthalmologists as an adequate means of determining the actual vision of individuals where occupation requires the observation of details at many times that distance. Some of the objections raised are: that the effect of different backgrounds can be determined only in a limited way; there is no method of producing the effects of different atmospheric conditions. None of the actual conditions found in railroad service is simulated, except the use of lanterns for testing color-vision. The standards should be based upon what the eye can see at one-half mile or beyond.

While these objections are valid and actual tests have shown conclusively that enginemen with greatly reduced vision, according to office tests, are able to determine the position of day signals and the color of night signals at remarkable distances, it does not indicate that an individual with 6/LX test card vision can read signals at anywhere near the distance one can who has 6/VI test card vision. The question is raised more for the purpose of arguing in favor of minimum requirement of less than 6/VI or 6/VIII vision and by those who favor a field test rather than an office test.

There is one decided objection to any office test for color-blindness; *no test so far devised will detect "chromic myopes,"* i. e., those whose color-vision is normal for objects within certain distances but to whom all colors beyond this limit are a neutral gray.

The following is a report of a few results obtained in the field tests made at Noble, O., in August, 1907. These were made upon enginemen long in service whose vision had become reduced in the majority of instances by latent refractive errors becoming manifest with increasing age. This report also shows the improved distance vision obtained by correcting errors of refraction and bringing the vision up to standard according to office tests.

Age, 42 years; service, 22 years; 16 years as engineman.

Daylight test:	Bright sunlight:
Both eyes (without glasses)	3,000 feet, read signals.
	3,000 feet, called flags.
Both eyes (with glasses)	5,280 feet, read signals.
Right eye (without glasses)	2,400 feet, read signals.
Night indication:	Weather clear:
Both eyes (without glasses)	2,700 feet, read signals.
Both eyes (with glasses)	4,000 feet, read signals.
Right eye (without glasses)	2,100 feet, read signals.

Chart test, August 31, 1907.

Vision:	Without glasses:	With glasses:
Right	20/70	20/30
Left	20/50	20/20
Combined	20/40	20/20

Age, 59 years; service, 44 years; 37 years as engineman.

Daylight test:	Bright sunlight:
Both eyes (without glasses)	2,000 feet, read signals.
	2,000 feet, called flags.
Both eyes (with glasses)	5,280 feet, read signals.
Right eye (without glasses)	1,100 feet, read signals.
Night indication:	Weather clear:
Both eyes (without glasses)	1,800 feet, read signals.
Both eyes (with glasses)	3,300 feet, read signals.
Right eye (without glasses)	1,250 feet, read signals.

Chart test, August 31, 1907.

Vision:	Without glasses:	With glasses:
Right	20/100	20/70
Left	20/50	20/20
Combined	20/50	20/20

History of visual tests.

Field of vision	*Interior of eye*	*Cause of diminished vision*
Normal	Healthy	Right eye amblyopic. Left eye, relaxed accommodation, as an accompaniment of age, in simple hyperopia of 1 diopter.

Age, 65 years; service, 20 years; 20 years as engineman.

Daylight test:	Bright sunlight:
Both eyes (without glasses)	2,900 feet, read signals.
	2,600 feet, called flags.
Both eyes (with glasses)	5,280 feet, read signals.
Right eye (without glasses)	1,700 feet, read signals.
Night indication:	Weather clear:
Both eyes (without glasses)	2,500 feet, read signals.
Both eyes (with glasses)	5,000 feet, read signals.
Right eye (without glasses)	2,400 feet, read signals.

Chart test, August 31, 1907.

Vision:	Without glasses:	With glasses:
Right	20/70	20/20
Left	20/70	20/20
Combined	20/50	20/20

History of visual tests.

Field of vision	*Interior of eye*	*Cause of diminished vision*
Normal	Healthy	Relaxed accommodation, as an accompaniment of age in simple hyperopia, of 2 diopters in each eye.

	R	L	C
May 18, 1903	20/100	20/100	20/40
June 11, 1904	20/100	20/100	20/50

Age, 53 years; service, 31 years; 28 years as engineer.

Daylight test:	Bright sunlight:
Both eyes (without glasses)	2,600 feet, read signals.
	1,800 feet, called flag.
Both eyes (with glasses)	5,280 feet, read signals.
Right eye (without glasses)	1,800 feet, read signals.
Twilight test:	
Both eyes (without glasses)	1,800 feet, read signals.
Both eyes (with glasses)	5,280 feet, read signals.
Right eye (without glasses)	1,400 feet, read signals.
Night indication:	Weather clear:
Both eyes (without glasses)	2,750 feet, read signals.
Both eyes (with glasses)	5,000 feet, read signals.
Right eye (without glasses)	2,600 feet, read signals.

Chart test, August 31, 1907.

Vision:	Without glasses:	With glasses:
Right	20/100	20/20
Left	20/70	20/20
Combined	20/70	20/20

Age, 51 years; service, 28 years; 25 years as engineman.

Daylight test:	Bright sunlight:
Both eyes (without glasses)	2,000 feet, read signals.
	1,500 feet, called red flag.
	1,400 feet, called white flag.
Night indication:	Weather clear:
Both eyes (with glasses)	5,280 feet, read signals, all colors.
Both eyes (without glasses)	2,200 feet, read signals.

While a candidate could at times distinguish night signals at 2,200 feet with both eyes without glasses, the next minute he would be unable to see them at all and it would be necessary to move up to within 700 feet before he could clearly distinguish signals, which indicated a varying condition of the eye, which very materially affected distances at which he could read signals. That condition did not appear to be present in the daytime.

Another peculiar condition was that with the very bright sunlight signals could be read 2,000 feet, and shortly after, when the sun had gone behind the clouds but still while it was bright daylight, signals could be read only at distances varying from 1,100 to 1,400 feet.

Chart test, August 29, 1907.

Vision:	Without glasses:	With glasses:
Right	20/200	20/20
Left	20/200	20/20
Combined	20/200	20/20

History of visual tests.

Field of vision	*Interior of eye*	*Cause of diminished vision*
Slightly contracted	Healthy	Compound myopic astigmatism

Grow points out that the simple tests in current use for candidates for the naval service do not eliminate dangerous amounts of hyperopia: and recommends a special examination to determine the amount of hyperopia, anything over 3 D. being a cause for rejection.

The value of field tests is certainly demonstrated in the reports on preceding pages. It is, however, a superfluous test with those having 20/20 vision: except as a night test for the purpose of detecting "chromic myopes."

An official of one of our largest railway systems volunteered the information, that the night field test was frequently tried with those showing color defects with the Holmgren and lantern tests and that invariably the same character of defect was demonstrated by the field test.

The enginemen, as a rule, would certainly prefer a field test to an office examination, as it would more nearly simulate actual working conditions. There are, however, several objections to this method; in the first place it consumes so much time; secondly, the roads would hardly go to the expense of building a testing line of sufficient length for such a purpose, and the congested condition of the traffic on the majority of the roads would not warrant the undertaking of such a method, as, in order to carry out the scheme fully, the examiner would have to arrange beforehand for designated signals to be in certain positions; thirdly, there would have to be a test for signals by night as well as by day; fourthly, the tests would not be equal, for some men would be tested under perfect weather conditions and others under adverse. The result is, we must be content with an office or inside test, the exception being those cases especially referred for such a test.

ADEQUACY OF VARIOUS TESTS FOR COLOR-BLINDNESS.

This subject is also discussed in Vol. IV of this *Encyclopedia;* e. g., unskillfulness in employing the tests, page 2371; futility of some tests, page 2374; superiority of lantern tests, page 2381; Adler's colored crayons unreliable, page 2388; fixity of tests; limited number of colors; liability of methods becoming known and understood, and thus rendered practically worthless; why some tests cannot satisfactorily be employed; prohibitive cost of apparatus in spectroscopic tests, as well as amount of time consumed; liability of complicated mechanism to become disarranged, and intelligence necessary on the part of candidate and examiner. Tests by means of subjective after-color sensations are unsatisfactory because of the vague subjective colors dealt with and the uncertain color intensities used. Adjustments of instrumental technique are also uncertain, and the tests have no advantage over the comparison tests with wools, etc., as shown on page 2443. Shadow tests may be easily guessed even by color-blind candidates, and require a large number of color shadows to be cast, as discussed on page 2459.

That the report of the committee appointed by the English Board of Trade does not meet the approval of many of the foremost ophthalmologists of the United Kingdom is evident from the following protest: "We consider the report, then, to be singularly defective: first, because

it fails to recognize that accidents caused by defective vision have happened and do happen; secondly, because it neglects the fact that quite a sensible proportion of officers at sea are color-blind and have defective form vision; thirdly, because it retains the Holmgren test, which has been shown to be utterly inefficient, and which allows a large percentage of color-blind persons to pass; fourthly, because it suggests a lantern which has no neutral modifying glasses; and, finally, because it retains examiners who are admittedly too inexpert to use anything like a proper instrument.

"As some sort of set-off, certain of the recommendations of the committee are excellent. They suggest that the responsible persons should be examined for visual defects, after accidents at sea. They have introduced a lantern, a bad one it is true; but then any lantern is better than none at all. They have advised that the higher standard of form vision be adhered to."

Edridge-Green pointed out many years ago the inadequacies of the Holmgren wool test (although Stargardt and Oloff give the priority to Nagel). He says: "The Holmgren test misses about half (or according to German authorities, more than half) of those who are dangerously color-blind, in addition to rejecting many normal-sighted persons and those with slight and unimportant defects of color perception."

He found that it was impossible to construct a wool test that was satisfactory and discarded it entirely for a lantern test in which the names of colors must be used.

The following is contained in the report of the committee of the Ophthalmological Society of the United Kingdom on color-vision, 1904:

"We agree with Edridge-Green that some cases of color-blindness cannot be detected by Holmgren's test, however skilfully and fully used; and that others that satisfy Holmgren's first test (pale green) easily, and would therefore be passed as normal in most ordinary routine examinations, are exposed by a careful use of Holmgren's second test (rose test color). We further agree with Edridge-Green that some at least of the cases just referred to, when tried with the signal lantern, make mistakes that at once disqualify them. The discovery of the defect in such cases can be made with certainty, and, as a rule, easily by a modification of the wool test, such as that of Edridge-Green, in which, as the result of his investigations, he recommends a series of colors different from Holmgren's."

Schlodtmann considers Holmgren's skeins not sufficient for exact determination of color distinction, and that Nagel's plates are much better, especially the required ability to distinguish slightly saturated green from the various shades of gray. For those who make only slight

mistakes with the latter test he recommends a practical test on a locomotive in the presence of an oculist and railway expert.

Abney, one of the strongest upholders of the Holmgren test, says of the three colors suggested by Holmgren as test-skeins: "The standard colors selected are most suited for the detection of complete or nearly complete blindness rather than for color-blindness which is incomplete and is small. . . . Except for the fairly pronounced examples of incomplete color-blindness, it is not uncommon for the incomplete color-blind to pass these three tests with but slight errors. . . . If the examinee is asked to name some of the confusion colors, the giving of the wrong name to any of them will confirm what has probably been found out by the matches."

Rostschewski-Saraton states most decidedly that the ordinary Holmgren test is useless. To get an accurate determination of the color-vision of the fovea the objects must not subtend a greater angle than 1 degree.

Nydegger says it may well be stated that the Holmgren color test, as employed in examinations for color-blindness, is in many instances unsatisfactory, and with our present knowledge inadequate, and should, when used, be supplemented by an additional examination, and is a matter which warrants earnest consideration. It has been shown that when used alone, the Holmgren method fails to detect all cases of color-blindness. He suggests that the worsted test should be supplemented by a lantern test, which is more accurate and better adapted for the detection of color-blindness.

The British Board of Trade has issued a report on the new sight tests used in the Mercantile Marine. This report covers the period of April 1st to Dec. 31st, 1913. An improved wool test, in which the candidate has to match five colors, and a lantern test were used. The cases of color-blindness are divided into those definitely rejected by the local examiners and those referred for a special examination, the local examiner being doubtful. Of the 286 definitely rejected in the local examinations, 148 failed in both the lantern and the wool test and 138 failed in the lantern test only; there was no failure with the wool test if they passed the lantern test. Of the 286, 93 appealed, 26 being successful. Of 125 referred cases, 20 were referred on both the lantern and wools, 101 on the lantern only, 3 on the wools only, and 1 on form vision as well. Of this number there were 30 failures; 3 of these were referred on both the lantern and wool test, 26 on the lantern only, and 1 on form vision as well. Those referred on the wool test alone were passed. From this report it is perfectly evident that the Board of

Trade will no longer rely on the wool test, and ophthalmologists presumably will be in accord with the Board.

The lantern test, while neither so accurate nor so severe as the laboratory color patch or dot test, is admitted to be sufficiently so for practical purposes, and is easily understood by the ordinary person who has no theories on color-vision.

Professor Stargardt and Fleet-Surgeon Oloff of the Germany Navy, from long-continued and mutual experience, state that they are unable to share the widely spread opinion that the whole question of color-vision testing in the army, the naval services, and on railways was settled, finally and absolutely, when Nagel's plates were adopted by law as the sole examination method used in the navy and on the railways; although they are greatly superior to the earlier tests, and especially to Holmgren's wool, they leave much to be desired and in practice are not always sufficient.

They state that "the Holmgren wool test and Adler's colored crayons must be rejected at once" and go on to say: "It would be better, if we could, to eliminate pigment tests entirely and use only the natural color of the spectrum which we obtain by the prismatic dispersion of white light in the spectroscope." This is prohibitive in practice because of the expense of a trustworthy instrument, quite apart from the fact that special knowledge of the physiology of color-perception is necessary for its use.

Dowdall of the Illinois Central Railway says:

"My experience has been that some of the men examined, who show defective color-vision with the skeins, show normal color-vision with the lantern test."

Ainsworth of the Southern Pacific says:

"We have found men to be color-blind with the worsted test but who could pass the lantern test, whereas we have never found a man shown to be color-blind with the lantern test, who had successfully passed the Holmgren test."

Knox of the Sunset-Central Lines says:

"The examiner carries the Williams lantern with him but it is only used to confirm the Holmgren test. We have found some who were only slightly defective with the yarns who did not do so well with the lantern, and vice versa. We have found the Holmgren test very reliable if properly handled and we do not think it necessary to use the lantern if the former is passed successfully."

Parker of the Michigan Central says:

"Examination for color-blindness made by worsteds is in every case confirmed by a Williams lantern. Personally I have lost confidence in

the accuracy of an examination made by worsteds only. I have had a few cases of men who could pass the worsteds perfectly, but were unable to pass the lantern, and many cases where the worsted examination left one in doubt were entirely cleared up by the use of the lantern. I think the lantern is absolutely essential for the proper determination of the color-sense."

Bohart of the Chicago and Eastern Illinois says:

"I personally made the examination in two cases, where men failed to pass the lantern test who had successfully passed the Holmgren test. It is just possible that I was the least bit careless in regard to the worsted test, but I laid out the three colors, rose, red and green, and they were matched perfectly with no apparent hesitation. In the lantern test the first two or three colors were properly called, and then the applicants became confused between the red and green, and the red was called green and the green was called red. Then I went over this test slowly again, and in both instances the applicants were confused on the reds and greens."

Mitchell of the New York, New Haven and Hartford says:

"We do occasionally find a man who has a scotoma or tobacco amblyopia, who is able to correctly identify the Holmgren worsteds, owing to the larger color-field presented by the skein at close range, but is utterly unable to identify the small lights of the Williams lantern and will perhaps call several of them white or one color in succession, which indicates that he sees the light but is utterly unable to distinguish the color. In regard to suggestions for the wool test, it seems to me that the Holmgren worsteds are very satisfactory in their present form and when used in conjunction with the Williams testing lantern, I believe sufficiently protect the corporation and the public."

The *Ophthalmic Review* (March, 1915), in commenting upon the report of the Committee of the Ophthalmic Section of the A. M. A. on Standards and Methods of Examining the Color-Vision, states "Though a lantern (Williams) is largely used it must be one which is almost useless because few of those using it have found cases rejected by it which have escaped the Holmgren test."

Taylor states that the old Williams lantern does not detect all cases of defective color-sense, and a modified lantern has been used by him for the past five years.

Relative to the lantern adopted by the Departmental Committee of the English Board of Trade, Edridge-Green says: "This instrument has no neutral tinted glasses, and shows one or two small lights simultaneously, which are reflected by a mirror. Having no means of regulating the luminosity of the light, the lantern can not detect cases

which have a shortening of the red end of the spectrum. The exhibition of two colored lights together introduces the phenomenon of simultaneous contrast, and is likely to cause the rejection of normal sighted individuals, and those with unimportant defects in color-perception." In his opinion this lantern test can be evaded by the color-blind who could be coached up in it to differentiate its colors by differences in luminosity.

Halliberton, Schafer, Porter, Percival, Taylor, Grossman and many others are unstinted in their praise as to the reliability of the Edridge-Green lantern in detecting color-blindness.

Stargardt and Oloff recommend Nagel's anomaloscope as being the test most free from objection and being necessary in the diagnosis of doubtful cases, but go on to state that it is possible that dichromatics and extreme anomalous trichromatics may match the colors either correctly or nearly so, and also if the examination is made absolutely according to the directions a large number of these anomalies will be overlooked; so that if they wish to avoid making mistakes in using the anomaloscope they must always begin the examination with Stilling's or the despised Nagel's plates and then employ the anomaloscope in a definite manner. The following is interesting in view of the foregoing: "After what we have said about the use of the anomaloscope, it is at once obvious that a certain knowledge of the theory of color-vision and its anomalies is necessary before it can be employed." The expense of the instrument is also a factor, against its use. "For these reasons the anomaloscope cannot be considered as a suitable instrument for general practice. . . . Stilling's test is not only to be recommended as a practical method but it is indispensable. . . . We have found that our results with Stilling's tests were always confirmed by the anomaloscope. We have also noted that Stilling's test has shown up errors of color-sense which have escaped detection by Nagel's test and the result has been confirmed by the anomaloscope."

Siklossy stated at the Fourteenth International Medical Congress at Budapest with reference to a suggested statute for the general inspectorate of the Hungarian railways and steamships that Nagel's plate test "is too difficult to manage." Answering the questions demanded too much "intelligence, education, and logical deduction" and was "too far advanced for candidates."

Stilling thinks that "Nagel's plates gave too much play to the judgment of the candidate, and that the distinction asked for between very dull greenish gray and pure gray left far too much to judgment."

Seydel comes to the same conclusion. Of 352 persons who, when tested with Nagel's plates, appeared to be color-blind, or at least

doubtful, 139, or 40 per cent., were found to have normal perception of colors when tested by other methods, Stilling's plates and the anomaloscope. He also has noted that Nagel's plates have been read "pat off" by color-blind candidates. He especially notes a case of well-marked deuteranopia in which Nagel's plates were read correctly. Seydel thinks that Nagel's plates are too difficult for many not exactly unintelligent persons, especially regarding the difference between gray and green. Further, the test allows too much room for the personal opinion of the examiner. One examiner may see color-blindness when a few green and gray spots are confused; another, less scrupulous, does not object to a candidate calling gray dots between red-green, and so overlooks an anomalous trichromatic. Seydel, since he has been able to conform his results by a more exhaustive method, has gradually lost confidence in the value of Nagel's tests.

Edridge-Green says that among the tests for color-blindness, pseudo-isochromatic methods have occupied a first place. If cases of color-blindness were identical, these methods would be more reliable than they are. Cases of color-blindness, however, differ; in fact, it is difficult to find two cases exactly alike. If a pseudo-isochromatic match be found for one dichromatic, and letters of the one color be printed on a background of the confusion color, he will not be able to read them. Another dichromatic, however, may be able to read these letters quite easily. For instance, he may have much greater shortening of the red end of the spectrum, and the subtraction of the red rays from one color will make that color much darker than the other confusion color. On account of the fact that simultaneous contrast is increased in the color-blind, it is necessary that both colors of confusion should correspond to two points well within the monochromatic regions of the observer. These are the main objections to pseudo-isochromatic tables if we exclude the extreme difficulty of accurately producing them. Quite apart from this, the fact that the two colors are regarded as identical by the color-blind can be utilized in a far easier and more satisfactory manner.

Van Marle thinks that color-blindness can be diagnosed with sufficient certainty by combining the pseudo-isochromatic tables of Stilling's with Nagel's lantern. Quantitative methods are necessary, however, to put the incomplete color-blind in their right place, but we have no reason to measure the phenomenon. The quantitative methods are those of Holmgren, Adler and Stilling; quantitative examination is also done with a lantern of Nagel's, the instrument of Herring or the lantern of Donders. Ole Bull's method is of little value for the abnormal color-sense. Color equations are made with Chibret's instru-

ment, but the data are unreliable. The best method of detecting the color-weak is the spectroscope, used by Donders on the instigation of Lord Rayleigh, but it is not suitable for polyclinic use.

Bekess considers the methods of Holmgren, Stilling and Nagel as practically equivalent and that any new employee who passes these examinations should be accepted. He thinks that the fault is not with the method but due to the unskilfulness with which it is employed. Therefore railway surgeons must be taught to conduct these examinations correctly.

The *Revista de Ciencias Medicas* thinks the Adler pencil or crayon test an excellent one for the following reasons:

1. It is rapid and can be easily employed by any physician.

2. There is no fear or suggestion in it, and it appeals to the one examined as objective and impartial.

3. A mistake is inexcusable—lack of light, confusion of shades, soiling of woods by exposure or use, etc., being impossible.

4. There is at the same time given a test of color-perception and documentary evidence of the tested person's capabilities.

C. Devereux Marshall believes that the "test most advocated by Stargardt and Oloff for general use is that of Stilling (which, however, is not based on the trichromatic theory), 'the results of which are always confirmed by the anomaloscope.' A great advantage according to Stargardt and Oloff lies in the fact that any naming of colors is unnecessary. When will the old prejudice against the use of names be laid to rest? If any person were to suggest that an examination, say, in surgery, should be conducted without the use of anatomic names or the names of instruments, would he be considered sane? What possible advantage can there be in examining a man in colors in dumb-show?"

Von Kries declares: "It is generally impossible to determine with certainty what or how other persons perceive and that it is in consequence of little value to know how an examinee calls this or that colored object."

Roemer in his text-book of ophthalmology holds that any method of testing color-perception in which the examinee is required to name the color cannot be regarded as decisive.

Stargardt and Oloff constantly find that they must as far as possible avoid naming colors if they wish to obtain accurate results, and have also found that the difficulty which persons have in naming colors has caused a great waste of time in examinations. This opinion is based on the use of Nagel's plates and his color-matching apparatus, the latter of which they accord as being "cheap and nasty" and just as useless as the anomaloscope is useful.

Edridge-Green says: "It is not necessary that the color names used be those used by me; any name will do. The essential point is that color-blindness is shown by a person including two colors of the normal sighted under one name."

C. Devereux Marshall asserts that, "Edridge-Green has shown that the test with Nagel's anomaloscope is hopelessly inadequate because many normal-sighted people vary greatly in the proportions of red and green which they use in order to produce yellow, while many color-blind people make the match with precisely the same proportions as the majority of normal sighted people." Further, "in a recent paper before the Royal Society, Edridge-Green showed that color-weakness and anomalous trichromatism are not necessarily associated and if this be so the test fails at once."

As a result of the examination of the color-vision of thirty-eight persons with Lord Rayleigh's color-matching apparatus, Edridge-Green arrives at the conclusion that inasmuch as four cases of ordinary green-blindness were "not only able to make the match, but mean variation is not excessive and not more than many persons possessing good color-perception. These cases definitely show that the opinion that appears to have held universally that the ordinary red-green-blind is not able to make a match with Rayleigh's apparatus is untenable."

Köllner has pointed out that all kinds of intermediate forms exist between normal color-vision, decided color-weakness and complete color-blindness, and that this circumstance introduces great difficulties in diagnosis. Rayleigh's matching test was responsible for much of the confusion which existed. In the form of Nagel's anomaloscope it had been adopted by the railways, and had almost brought the method into discredit, because candidates who showed abnormalities with the anomaloscope appeared to be normal when tested with other apparatus. The reverse condition has also been noted; candidates rejected by ordinary tests matched the Rayleigh spectral colors without difficulty. This apparent paradox only applies to the match between yellow and the red-green mixture, and depends on the relative brightness of the colors. With correct regulation of this factor, Köllner finds that all persons with color-weakness can be unmasked with Rayleigh's apparatus.

Köllner comes to the following conclusions:

1. Up to the present every person who has appeared abnormal when tested by other methods has made mistakes with the anomaloscope.

2. On the other hand, Rayleigh's apparatus has detected abnormalities which do not render the individual incapable of distinguishing color for all practical purposes.

3. The difference in the brightness of the fields has so much influence on the test that great care must be taken to exclude this source of error.

Angstein, who in the last twenty-five years has examined 3,044 persons for the railway department at Bromberg, notes that the deeper one goes into the difficult question of color-vision, the more all observers are agreed that all defects occur in a graduated manner. They gradually increase from the smallest anomalies, which are only detected by the anomaloscope, to gross forms, in which spectral red and green are confused. He then discusses the question as to what degree of abnormality must be held to render a man incapable of service on the railway, and what tests enable us to settle this question. He agrees with Stargardt and Oloff as to Nagel's test and is surprised at the small recognition accorded Cohn's test. He says: "The final conclusion is, that to detect color-blindness two tests are needed, Cohn's and Stilling's. In compensation cases, Nagel's test and the anomaloscope must be added. It is of no use to place the anomaloscope in the hands of an ordinary railway doctor, because he rarely has the necessary knowledge to use it." The Holmgren test is not even discussed.

According to Jeffries, Cohn's "embroidery patterns" detect color defects only when the colors of the letters and background are just suited to the special kind and degree of color-blindness of the examinee. Also that Daaes color tables require confirmatory tests by some other means in most cases.

ADVANTAGES AND DISADVANTAGES OF GLASSES IN ARMY, NAVY AND RAILWAY SERVICE.

The *objections* to the wearing of glasses in the above mentioned services are not many but on first thought they may seem serious. The following list about covers them: (1) They become smeared and dirty; (2) they become covered with fog, mist, rain or snow; (3) they become fogged on coming from cold into warmth; (4) they are always in danger of being broken; (5) glasses which give a visual acuity of 6/VI (20/20) with an office test do not give an equivalent visual acuity of 6/VI (20/20) when used at long ranges, particularly under certain weather conditions.

On the other hand, the following are some of the distinct *advantages* of glasses: (1) The correction of refractive errors in marksmen, railway men, etc., repairs the loss of vision due to latent hyperopia becoming manifest with increasing age, in men long in army, naval or railway service; (2) relief from glare by wearing colored lenses: (3) improving distant vision with colored lenses by eliminating haze-

producing factors in the atmosphere; (4) protection, especially in railway service, against the effects of wind, dust, mist, rain, snow and sleet; (5) in railway service relieving the reflection when running beside rivers or lakes, from snow in the winter time and from sand in Western deserts; (6) overcoming the disturbance of vision in railway service when running toward electric or acetylene headlights and when running toward the rising or setting sun; (7) doing away with the disturbing effect of glare and heat from the fire-box during the stoking of an engine; (8) the protection afforded in railway service against many serious eye complications, produced by hot cinders, burns, scalds, etc.

There are no particular disadvantages in the *use of glasses in Army service* other than those which are commonly raised against wearing glasses in any walk in life. Many officers wear them constantly and candidates for West Point are accepted with low refractive errors which may be overcome by corrective lenses.

Lt. Col. J. M. Banister and Major Henry A. Shaw (*Circular No. 5*, War Department, 1908) after making many careful tests with ten sharpshooters firing five shots with the naked eye, five each with vision blurred by plus lenses to make it 20/40, and five each with vision blurred to 20/70, in which the results were equally good arrived at the following conclusions: 1. That a perfectly sharp image of the target or bull's-eye is not necessary for good shooting. 2. That a visual acuity of 20/40, or even 20/70, in the aiming eye is consistent with good shooting, provided that the soldier is able to accurately focus the sights of his rifle. 3. That as rifle shooting is an act of monocular vision a comparatively high standard of vision is necessary for one eye only. 4. That with regard to the visual acuity necessary to the perception of distant objects a soldier with a visual power of 20/40 in the better eye and 20/100 in the poorer will be able to meet all requirements for service in the field. 5. That in consequence of the different visual requirements of the various branches of the service a graded standard of visual acuity should be adopted.

Their deductions are that sharp, clear-cut vision of the target or bull's-eye is not necessary, the essential factor being an accurate focus of the sights.

J. A. Donovan in criticising this report remarks that "They (Banister and Shaw) do not take into account that once the expert finds the bull's eye and is 'holding' well he can make each successive shot come near the other as long as he retains his fixed position. Nor do they consider that the bull's eye is a spot; thus its distinctness depends on its illumination, and the law applicable to Snellen's test type would

not bear the same relation. I have shown that the bull's-eye has sufficient size to be easily discernable by a man with at least 1/3 normal vision.* The only requirement is to have sights distinct enough to produce a definite retinal impression, once they come into perfect alignment with the object; the sharp-shooter then becomes unconscious of his sights."

Donovan concludes: "The eyes of the expert rifleman require the greatest care. Full correcting lenses should be not only allowed, but constantly worn. They must be made high enough, in far enough and large enough so that when the head is down and the eye looking upward to almost its limit, vision will be distinct through the glass. The cylinder, if strong, must be rotated in the trial frame, with the head in the firing position, to determine that vertical lines appear as such with the glasses on; otherwise, the rifle will be canted and will shoot to one side. A toric lens is necessary, and for shooting in bright lights or artificial lights, a light-amber or some other color is essential. For presbyopia, bifocals are preferable or a pocket lens should be carried to adjust the sight and do other near work. . . . Finally, to the ametrope, large, tinted lenses, properly correcting the ametropia and snugly fitting, will more than compensate the soldier, in relief from fatigue, and in the protection of his eyes from accidents, for all the disadvantages at present urged against them. The frame should be of stiff material, solid temples with soft ear pieces."

This is the consensus of opinion among ophthalmologists.

Glasses in naval service. The Departmental Committee of the British Board of Trade (1912) in answer to the question: "Is it practicable for Navigating Officers to use spectacles to improve their distant vision?" gave the following answer: "The evidence which we have heard given by nautical witnesses forces us to the conclusion that with every allowance for exceptional cases the circumstances which attend navigational duties render it quite impracticable to allow officers to depend upon the aid of spectacles for distant vision."

This conclusion is assailed in no uncertain terms by Karl Grossmann (*British Medical Journal*, Oct. 19, 1912). Some of the objections made to the use of glasses at sea are: "Even if it were possible to prevent glasses from getting broken and mislaid, fog, mist, and spray would render them useless." Practically the same objections are made in the United Kingdom and upon the continent to the wearing of glasses

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* Dimension of bull's eyes used in target practice in U. S. Army: for 200-300 yards range, 8 inches; for 500-600 yards range, 20 inches; for 800-1000 yards range, 36 inches.

by enginemen and firemen. This subject has been thoroughly considered in this country and the leading opinion of the ophthalmologists in the United States is that enginemen and firemen are decidedly more efficient while wearing glasses for protection and to correct refractive errors. The result has been that the railway officials of the largest systems in the United States and Canada not only do not object to the use of glasses in service, but advise and require their use, with the idea of preserving the eyes and vision of their employees. The arguments raised as to the disadvantages or the impracticability of the use of glasses in naval service are essentially the same as those arising in railway service and actual use and experience has shown conclusively the objections are theoretical only.

It is a well known fact that men entering the railway service at from eighteen to twenty-five years of age may possess from 1—4 D. of latent hypermetropia and a considerable amount of astigmatism, and be able to pass the required examinations, as many are now conducted, with ease, the muscle of accommodation being able to overcome the latent refractive error.* These men on coming up for re-examination five, ten and fifteen years later will be unable to meet the required standard of vision because of a reduction in accommodative power from increasing years. They are at their most useful time of life in all other respects, their experience resulting from long years of training and the caution acquired with advancing years more than compensates for the loss in vision, and when it can be brought up to the standard required with glasses, renders them far more useful and safe than those with perfect eyesight and less experience.

With the vision of these men raised to the required standard and protected from wind, dust, mist, rain, snow and sleet by glasses, it stands to reason they are safe men, safer in fact than the man with standard vision who has less experience and unprotected eyes.

The protection afforded the eyes by glasses against the impact of wind, dust, rain, snow and sleet, when an engine is traveling from 35 to 70 miles an hour, can only be appreciated by one who has experienced it, and it is absolutely necessary for an engineman to have his head out of the cab window more or less, in order to be sure of his signals in such weather conditions.

The protection of firemen's eyes is of especial importance for the reason that the engineman almost always calls on his fireman to verify

* The rules governing the examination of railway men in force on the New York Central system eliminate a certain per cent. of the hyperopes. See rules 2 (f) and 20 in this section.

signals located at points of importance or where the signal is somewhat obscure; and with the scotoma produced in the naked eye from the fire-box this is almost impossible.

The use of tinted glasses. Objectionable reflection from snow, and from bodies of water, not to mention the disturbance of vision when running toward the rising or setting sun, the glare and heat of the fire-box and the intense glare from opposing acetylene and electric headlights—all these are best met by the use of colored lenses. Such glasses must have peculiar characteristics to meet satisfactorily the requirements under all conditions.

1. They must relieve the eyes from glare without reducing to any appreciable extent the proper amount of light entering the eye, or the object desired will be defeated. An insufficient amount of light striking the retina will not produce the required stimulus necessary for sharp, quick vision, which also brings about the proper pupillary control to admit of the least amount of chromatic and spherical aberration such as obtains with dilated pupils.

2. The glass must have the power of absorbing those rays of the various spectra of the illuminants met with in common use, which in their diffused, refracted and diffracted state produce fog and haze and thus obscure distant objects.

3. The glass must be such as may be ground to correct various refractive errors and still maintain its depth of color.

4. The glass must be such as will not diminish the intensity or the hue of night color indications, or, in other words, cut down the range of a night signal.

All colors have been tried with the result that until the summer of 1913 ophthalmologists and railroad men were almost unanimously in favor of amber-tinted glasses.

It has been determined that the good results obtained with the amber-tinted glass, is due to the partial absorption of the invisible ultra-violet of the spectrum, and the violet and blue rays of the visible spectrum, which are the important factors in producing glare effects. The haze in the atmosphere which tends to obscure distant objects is also the result of the refraction, diffraction and diffusion of the more refrangible rays of the solar spectrum; i. e., the blue, violet, and ultraviolet rays. Thus a glass which will partly absorb, or filter out, such rays will relieve the eyes to a marked extent from glare and also improve vision.

The glass largely used by enginemen and firemen at present and which is recommended by the officials of many roads is a medium

shade of amber. This glass partially cuts out the ultra-violet rays of the invisible spectrum, and slightly reduces the intensity of the violet and blue rays but is not a sufficient protection to the eye from the glare-producing effects of the visible spectrum. Fieuzal, Euphos, Hallauer, Akopos, Radex and many other glasses of like nature have been suggested for the purpose. However, while they meet the requirements above mentioned to a small degree, and while practically all eliminate the ultra-violet and a portion of the visible violet and blue, if of a shade of sufficient depth to act as a real protection against the glare from the fire-box and approaching headlights, they diminish the intensity and hue of night signals to a marked degree and consequently reduce their range. For this reason they are a menace when worn by individuals with weak chromatic sense, especially in unfavorable weather conditions. It is well known that as a result of the present unscientific manner of carrying out examinations for color-vision, chiefly due to the employment of untrained men who make the examinations in the majority of instances, as well as to the imperfect methods used, many candidates with defective color-perception are passed as normal.

A glass called Noviol, meeting the above requirements and having to a markedly less degree the disadvantages above mentioned, has recently been placed upon the market. In its deepest shade (it is supplied in light, medium and deep shades) Noviol glass 1.6 mm. thick transmits (including reflection) 87.9 per cent. of the incident light. All wave lengths of the spectrum shorter than 470 $\mu\mu$ are absolutely absorbed; i. e.:—red, orange, yellow, and a small percentage of the blue are transmitted; no violet or ultra-violet. Of the heat rays, or infra-red radiations, 48 per cent. are absorbed. Thus it seems to be a glass which comes closest to meeting every requirement of the railway service.

The following from Warren S. Stone, Grand Chief, Brotherhood of Locomotive Engineers, bears out the above statement: "I question very much if Noviol glass can be improved upon. I believe on account of the rigid visual examinations to which the men in engine service are subject, that the time has arrived when they should use a protective glass of some kind, not only to protect their eyes from the wind strain, but also to give them protection from the arc lights, which are now in universal use in every town, many of them being hung directly over the right of way, and also the glare of electric headlights on double tracks. Everywhere I go I recommend to the men that they use a protective glass and I am trying to impress upon them the importance

of making every effort to preserve their eye-sight, because it is the most valuable asset that the man in the cab of a locomotive possesses today."

With deep Noviol glass the hue of the standard red signal is apparently unchanged. The composition of the glass in the green signal for use with coal oil illumination contains considerable blue, which is to neutralize the large percentage of yellow in the coal oil flame used to illuminate the signal lamps, the effect of the Noviol is to make this signal a more intense green. Blue and purple roundels have in their composition a large percentage of the red, green and yellow and are seen as yellowish and reddish-green. However, with the present illuminate (oil or incandescent lamps) blue and purple are only used for short range signals on account of their low intensity.

Again quoting from Grand Chief Stone "The only objection to deep Noviol is that it is hard to distinguish blue. We knew that it would have this effect and I am surprised to learn that any road is using blue for its signals. The only blue signal that I know of is that used when car repairers were working upon a train; then they always hang out a blue flag or a blue light."

Medium shade Noviol is suggested as best adapted for the use of enginemen and firemen unless the eyes are very sensitive to light, when the deep shade should be used.

PROTECTION OF THE EYES.

Conservation of vision—"safety first"—by attempting to prevent accidents to the eye is a question which practically every large manufacturing establishment and corporation has seriously considered. Protective glasses or goggles being furnished by the company gratis to their employees, and in many instances stringent rules relative to their being worn in all hazardous occupations enforced. The Wisconsin Industrial Commission having ruled that in case of accident in which protective measures are provided by the employer gratis, the indemnity resulting in the case of accident is subject to 15 per cent. reduction where such protective means are not made use of by the employee.

The importance of the use of protective measures in railway service, especially in the occupation of enginemen and firemen, may be appreciated from the following report of claims paid on account of *total* and permanent loss of sight in one or both eyes by the Locomotive Engineers' Mutual Life and Accident Insurance Association from June 1, 1905, to April 10, 1915, inclusive. This report was furnished by M. H. Shay, General Secretary and Treasurer.

		Membership
June 1 to Dec. 31, 1905	12	June, 1905, 43,857
Jan. 1 to Dec. 31, 1906	35	June, 1906, 47,519
Jan. 1 to Dec. 31, 1907	36	June, 1907, 52,340
Jan. 1 to Dec. 31, 1908	50	June, 1908, 55,918
Jan. 1 to Dec. 31, 1909	39	June, 1909, 56,841
Jan. 1 to Dec. 31, 1910	39	June, 1910, 59,608
Jan. 1 to Dec. 31, 1911	22	June, 1911, 63,155
Jan. 1 to Dec. 31, 1912	21	June, 1912, 64,984
Jan. 1 to Dec. 31, 1913	51	June, 1913, 67,540
Jan. 1 to Dec. 31, 1914	14	June, 1914, 69,497
Jan. 1 to Apr. 10, 1915	4	April, 1915, 69,273
Total	323	

An analysis of the causes of blindness and of the cases in which removal of the eye occurred is given as follows:

Eyes blind from injuries (traumatic cataract)	8
Eyes blind from injuries nature not stated	39
Eyes blind from injuries nature stated	62
Eyes removed on account of injuries (nature not stated)	36
Eyes removed on account of injuries (nature stated)	12
Total	157
Eyes blind, cataract	50
Eyes blind, disease	63
Eyes blind, no cause given	22
Eyes removed, no cause given	28
Eyes removed, diseased	3
Total	166
Grand total	323

Since 1909 the use of glass for protection as well as for correction of refractive errors has been encouraged by the officials on many lines. Notwithstanding the large increase in membership during this period apparently the number of eyes lost from injury has decreased.—(N. M. B.)

Eye-souffle. A murmur said to be heard in anemia by means of the stethoscope on the globe of the eye.

Eye-speck. EYE-SPOT. OCELLUS. See **Comparative ophthalmology.**

Eye speculum. See **Speculum.**

Eye-stone. A small, calcareous, disc-like shell, the orperculum of various Gasteroped molluscs; also a flattened concretion from the stomach of a European crawfish, the *Lapillus cancri.* In domestic practice it is placed under the eyelid for the removal of a foreign body that has found its way into the eye, being put into the inner corner of the eye and allowed to work its way out at the outer canthus.

Eye-strain. This extremely important, though ill-defined and often complex subject, touches many departments of ophthalmology. In one sense the term is almost synonymous with *asthenopia* (see p. 651, Vol. I, of this *Encyclopedia*); quite as frequently it happens that the symptoms of eye-strain are not so much due to weakness in or defects of the ocular apparatus (especially *ametropia* and *heterophoria*) as to positive abuse of the system generally, or of eyes that are themselves practically normal. This latter aspect of the subject has been considered under **Conservation of vision,** and to some extent under the caption **Blindness, Prevention of.** The other portions of it are discussed under a number of headings, particularly **Headache, Ocular; Refraction and accommodation,** as well as under **Muscles, Ocular** and **Fatigue.**

In 1910 the Census Bureau issued a classified list of between 7,000 and 8,000 separate and distinct occupations. Dividing these occupations into groups, designed to indicate their rôles in creating or increasing the disease directly or indirectly the result of eye-strain, it has been shown that the least eye-strain will, as a rule, be found in that group classed as farmers, agricultural laborers, common laborers, soldiers and railway workmen; and the most eye-strain found in the group classed as students, clergymen, all professional men, clerks, engravers, draftsmen and the like.

In the first group, composing 40 per cent. of the population, 1 to 20 per cent. have ocular or eye-strain diseases. In the last group, composing 20 per cent. of the population, 80 to 100 per cent. have ocular or eye-strain diseases. Eye-strain increases with work at near range—as in office, store and home—and the modern growth of population is largely taken up by the town and city. The nearer the work, and the more minute, the greater the eye-strain. The more constant this focalization, the more severe the eye-strain. With decrease of the illumination below a high physiologic standard there is a geometrical increase of eye-strain. It is a well-established fact that either the overuse of the eyes, or the use of eyes under bad conditions, may give rise to eye-fatigue or to eye-strain, and many eye specialists believe that at least 80 to 90 per cent. of headaches are dependent on eye-strain.

It is impossible to ignore the probability that many individuals working by gas light, or even by electric light, in dirty, unpainted, overheated rooms, with impure air and excessive moisture, for ten hours a day, or merely for the last two hours during the day, use up a great deal of nervous energy and suffer from eye-fatigue or eye-strain and its consequences.

Of late years increasing attention has been given to working conditions in factories, shops and offices in regard to illumination, ventilation, hours and character of work, and this is bound to result in greater efficiency and less time lost in sickness and nervous disorders.

The probabilities are that the eyes of the human race are neither weaker nor stronger today than were those of our forefathers, unless it can be proven that the whole physique of the race today is weaker or stronger. As is the whole physical body, so are the eyes.

But much more is required of our eyes now than was ever required of our ancestors. The strenuous struggle for existence today, the ever increasing complexity of our modern civilized life, the multiplying knowledge of the world in all lines of human endeavor, knowledge that must be mastered if we would rise and achieve success, put far greater strain on the eyes of this generation than on those that have gone before.

Our schools are far more exacting and severe, the business and scientific world require closer application and more painstaking care than ever before. Electricity has turned night into day, and much more work is now done by artificial illumination than in the past. Sharp competition in every line makes it necessary to have the best vision obtainable.

Because of these exacting demands on our eyes latent imperfections, errors of refraction causing eye-strain, are brought out and made manifest by symptoms of discomfort and distress, compelling us to seek the improvement of vision and the comfort afforded by properly fitting lenses.

Investigation has shown that primitive races of men have the same irregularities in shape and form of the eyes as are found in civilized races. The difference lies in the occupation, out-of-door life, and the limited use made of the vision by the savage races.

Examination of the eyes of the Indian students at Carlisle and other Indian schools shows that about 30 per cent. of them have refractive errors, and need correcting lenses. This is approximately as large a percentage as is exhibited by the white races.

Even the lower animals show the same irregularities and imperfec-

tions in shape and form of eye which give rise to the discomforts caused by refractive errors in man.

The percentage of people wearing glasses, in a community, or group, or society, is an index to the educational and scholastic attainments of that group or society. The more the eyes are used for prolonged study and close work, the more necessary it becomes to wear correcting lenses for any existing refractive errors. It will frequently be found in any group of professional and scientific men, scholars, professors, teachers, lawyers, doctors, etc., that from 30 to 60 per cent. of them are wearing glasses.—(*Bulletin Jour. A. M. A.*, May 17, 1915.)

In passing, it must be remembered that general diseases and the nervous inability following or accompanying these, as well as that condition of the brain or cord, neurasthenia itself, may be wholly or in part the cause of eye-strain. An excellent paper on the former subject is by A. A. Bradburne, in the *London Lancet,* p. 698, Mar. 11, 1911.

The relations of eye-strain to crime is discussed on p. 3560, Vol. V, of this *Encyclopedia.*

Gould (*Jour. A. M. A.*, p. 2254, Dec. 21, 1912) points out that the cinematograph is well adapted to develop the symptoms of eye-strain, especially in eyes with uncorrected ametropia. The fixation point is unstable, tremulous and jerky. The individual images generally follow each other on the screen so slowly as to be separately perceived; instead of making a continuous impression. The ceaseless, exacting conflict of impressions of different parts of the picture, and the poor illumination tend to make matters worse. The symptoms of eye-strain from this source, as noted by Bahn (*New Orleans Med. and Surg. Jour.*, p. 304, Oct., 1912), include injection of the lid margins and conjunctiva, lachrymation, retinal fatigue and a sense of tire, heat in the eyes, pain in the ciliary region, headache, muscæ volitantes, and dizziness. Even when favorably presented the moving pictures constitute a severe test of distant vision and endurance.

Since inadequacies of focus or motility of the eyes may give rise to disturbance of digestion and assimilation; and lowered vitality, especially in the neurotic, predisposes to tubercular infection, Lewis (*Trans. Sec. on Ophth. A. M. A.*, 1908) thinks that every patient suspected of having tuberculosis should have a complete examination of the refraction and motility of the eyes. He reports two cases in which very serious disturbances of nutrition, and nausea with intestinal indigestion, were relieved by the correction of errors of refraction, and marked gain in weight followed. Shannon (*Amer. Med.*, May, 1908) also re-

ports three cases in which the patients who had broken down in general health recovered by the wearing of correcting glasses.

The treatment of eye-strain has been indicated in the foregoing account of its causes. The most important consideration is, of course, the correction of the sufferer's ametropia and, if it appears to be responsible for any symptom, of his heterophoria. Improvement in defective health and avoidance of abuse of reading, studying and similar pursuits are also essential to recovery; indeed, persons who suffer from eye-strain should carefully follow all the well-known rules of ocular hygiene.

For example, Carhart (*Med. Review of Reviews*, Sept., 1908), speaking of the mental and ocular overstrain involved in the education of children and in the occupation of many adults, suggests, for the former especially: 1. That no calendared or coated paper be permitted in the text-books given to children, as the dazzle of such paper is injurious to their eyes. 2. That half-tone pictures be not permitted in school books, but that simple, easily seen outline pictures be substituted for them. 3. That the length of lines in school books be of a minimum of two and one-half inches to a maximum of three inches, with a space between the lines of not less than 3 mm. 4. That in reading the child be advised to hold his book at an angle of approximately 45 degrees, and that in oral reading they be required to look up frequently. 5. That after a lesson demanding close work the children be asked to look up at the ceiling or out of the window to change the focus of their eyes and rest the muscles of accommodation. 6. That class rooms be equipped with loose chairs of different sizes so that the children may sit in seats that fit them and placed where they can see best. 7. That in the first two years of school all writing be upon blackboards instead of upon paper. 8. That all rooms where artificial light is burned continually be closed; that no part-time classes be permitted to occupy any room in which the light is not entirely satisfactory. 9. All electric light bulbs used in lighting class rooms to be made of frosted glass, and that clusters of such bulbs be provided with pale amber shades to screen the pupils' eyes from the direct rays of the light.

Again, after an apparent cure of a local or constitutional disease, especially after recovery from the acute exanthemata, children so affected should be granted a considerable vacation, and that is the eye-strain which almost invariably accompanies these diseases, and continues with the sufferer for some time after apparent bodily recovery. If we permit children so to enter school at once, at the time when the physicians permit them to return as free from contagion, there is great probability that bad results will follow, so far as the

eyes are concerned. For they are at this time weakened for use at near objects, and the sudden exertion demanded from them, as, for instance, in writing in a book and then looking at a distant blackboard for notes, or in looking at a book and then at an example on the blackboard, exerts the accommodation of the eyes to an unusual degree and leads to eye-strain from which recovery may not take place for months. Instances of this sort have also been recently observed after the mumps, in which the eyes could not be used for near work for seven weeks, the least exertion being followed by a flow of tears, smarting and burning of the eyes.

Instances of this sort of eye-strain, occurring daily in the practice of oculists, prove how intimately the eyes are connected with the body and the folly of regarding them as mere things by themselves, the sight of which needs only to be tested by inexperienced men. People have to be taught by constant repetition, that the eyes are a part of the body, and are constantly exhibiting symptoms, such as have above been mentioned, to prove their close relationship.—(*Journ. A. M. A.*, Oct., 1914.)

A. J. Sweet (*Practical Medicine Series*, p. 34, 1913) regards defective or other improper illumination as a prolific source of eye-strain and condemns any condition of illumination which, under normal conditions of service, permits light-giving or light-reflecting objects to send light into the eye to a degree vastly in excess of that required adequately to disclose these objects. In practice this would involve the observation of at least the following principles: Avoid the necessity of performing close visual work when facing any considerable window area. In interiors where close visual work is performed, employ as dark walls as possible, avoiding, however, a gloomy or depressing effect. Employ white or very light ceilings that glare from glazed surfaces may be reduced. In interiors where close visual work is performed, the light units should have a moderately broad type of distribution, and should not be spaced too far apart, in order that surfaces may be lighted from a large number of different directions, and glare largely eliminated. If highly glazed surfaces must be employed under conditions requiring close visual work, light by indirect or semi-indirect units. Avoid glazed surfaces so far as possible. Mount the light units high, well out of the field of vision. Avoid the use of wall brackets, which are not only an inefficient method of lighting, but highly objectionable because of the amount of light which they throw into the eye. Remember that these objections to wall brackets are not removed by surrounding the light unit with a diffusing shade. Unless the walls are very dark, employ types of light units throwing as little light on the walls as

possible. In the present state of the art, the least possible will be too much. Avoid the use of types of units characterized by relatively high candle-power values in the zone between 50 degrees from the vertical and 90 degrees from the vertical. Avoid over-illumination of the work as zealously as under-illumination.

The relations of *eye-strain to epilepsy* have already been discussed on p. 4484, Vol. VI, of this *Encyclopedia*. E. H. Linnell (*Jour. Ophthal., Otol. and Laryng.*, May, 1915) believes that true epilepsy may result from long-continued irritation of the nervous system in individuals where it is unstable. He thinks errors of refraction and muscle balance may serve to cause this irritation and in the course of time epilepsy develops and becomes chronic. He reports two cases cured by the correction of low errors of astigmia, and muscle balance.

Eye, Tea-leaf. A peculiar pathologic condition of the eye which exists among the lower classes of the Southern States, especially negroes. It is produced by poultices, particularly one of tea leaves.

Eye, Third-rail. A diseased condition of the eye due to minute particles of metal that have fallen in it from elevated railways.

Eye, Trichromic. A term used in speaking of theories based on the assumption that there are three primary color-sensations. See **Color-sense and color-blindness.**

Eyewart. See **Euphrasia.**

Eyewater, Benvenuto's. See page 932, Vol. I, of this *Encyclopedia*.

Eyewater, Horst's. See **Horst's eyewater.**

Eyewater, Sattler's. See **Sattler's solution.**

Eye-winker. An eyelash.

F

F. Abbreviation of *Fahrenheit* and (in prescriptions) of *Fac.*, make, and of *Fiat*, let there be made; also employed by some as the chemical symbol for *fluorin.*

Faba calabarica. (L.) Calabar bean.

Fabini, Friedrich. Born at Siebenbürgen, he received his medical degree at Pesth, Hungary, in 1822. In 1823 he became Fellow of the Medical Faculty at Pesth. A year or two later he settled at Klausenberg, where he practised for many years. His most important ophthalmologic writings are: "Beobachtungen über den Grauen Staar" (v. Graefe u. Walther's *Jour. der Chir.*, xiv, 1830); "Pflege Gesunder und Kranker Augen" (Leipsic, and Pesth, 1831, 1835).—(T. H. S.)

Fabini, Johann Gottlieb. Born at Siebenbürgen about 1786, he obtained his medical degree at Vienna, presenting as his dissertation "*De Amaurose.*" In the same year he became Assistant at the Public Eye Hospital, Full Professor of Ophthalmology at the University of Pesth, Director of the Institution for the Indigent Blind, and Superintendent of the Infirmary for Eye Patients. He wrote: 1. "*Doctrina de Morbis Oculorum*" (Pesthini, 1823. This book is called by Hirschberg "die letzte Lateinische Augenheilkunde.") 2. "*Prolusio de Precipuis Cornea Morbis*" (Budae, 1830). 3. "*Einige Bemerkungen über das Schielen*" (*Med. Jahrb. des. k. k. Osterr. Staates*, xxxiv, 1841.) 4. Numerous articles in the *Encyclopedic Dictionary of the Medical Sciences* and in "*Orvosi Tár.*"—(T. H. S.)

Fabricius ab Acquapendente. See **Fabricius, Hieronymus.**

Fabricius, Hieronymus. He is also called Fabicius ab Acquapendente. Born in 1537 at Acquapendente (Aquila Tuscia) near Orvieto, Italy, he studied, at Padua, first the ancient languages and philosophy, and, later, medicine and surgery. He was pupil and successor of Falloppio, as well as eminent teacher of William Harvey, the discoverer of the circulation of the blood. Though Fabricius was one of the most celebrated surgeons of all time, and author of the greatest work on surgery composed in the Renaissance period, he nevertheless possesses but little ophthalmologic importance. Thus, his ocular operations are all essentially taken from the Greeks and the Arabians—chiefly Celsus, Paulus and Albucases—and he even admits that he himself has per-

formed the cataract operation only twice or thrice all told. Later, he renounced this operation absolutely, recommending for cataract the use of a certain collyrium in an eye-cup. Fabricius died of gout and asthma, Feb. 14, 1634.—(T. H. S.)

Fabricius Hildanus. See **Fabry, Wilhelm.**

Fabriz, Wilhelm. See **Fabry, Wilhelm.**

Fabry, Wilhelm. He is also called Wilhelm Fabriz, Fabricius Hildanus, and "The Other" Fabricius (in contradistinction to Fabricius ab Aequapendente). The son of P. A. Fabry, clerk of a court at Hilden, Germany, the subject of this sketch was born at Hilden (hence the name, "Hildanus"), June 25, 1560. He was a classical scholar and a brilliant and resourceful surgeon. He is often called, and properly, "the first learned German surgeon." He was the first to amputate the thigh, and was equally daring and ingenious in otology and ophthalmology.

He is often said to have been the first in history to remove from the eye a piece of steel or similar foreign body by means of the lodestone or magnet. This honor, no doubt, belongs to Braunschweig, or Brunswick (q. v.), but Fabry's operation is, nevertheless, so extremely important and the original narrative thereof is so quaintly exact and interesting that we here subjoin an almost literal translation:

"A patient from the region of the 'Bieler See' wishing to buy a fire-steel, first tested it by striking it on a stone. A spark then flew up into that part of the cornea, where the iris can be seen, and took fast hold, under heavy pain. His neighborhood employed upon him for many days all its industry, but in vain. When the pain and inflammation had powerfully increased, he came to me at Bern on the 5th of March, 1624. I put him on right diet, emptied his body by purgatives and phlebotomy, for he was plethoric, and sought at various times and on divers days to remove the iron splinter. But it was so small that it could not be removed by means of instruments. Then my wife thought up the most appropriate cure. While I, that is to say, with my two hands, open the lids, brings she the magnet to the eye, as near as the patient can bear it. When we had done this many times and repeatedly (for not long could he bear the daylight, which however in this matter was an absolute necessity) then, finally, sprang forward before our eyes the splinter onto the magnetstone. After that, the patient got well rapidly under the employment of a pain-relieving collyrium. So you see that much which cannot be carried out by main strength can be easily performed by care. One must, however, well observe that mostly the opposed powers of this magnetstone must be found in one and the same piece—that is, that

the iron attracts at the one end, but at the other repels: which indeed was looked after in the case of our magnet. In order, therefore, to avoid error, one must, before the operation, test all the corners of the stone exactly, in order that no part which drives iron away from it may be brought toward the eye. That is, moreover, easy to test, by bringing the magnet gradually toward iron filings which have been strewed upon a table or on a clean piece of paper."

Another remarkable operation of Fabry's (which, once more, he was not the first, but the second, to perform) was that of total removal of an eyeball. This operation (which he carried out in the case of a very old man with a prominent, blind, and extremely painful eye) he performed in the following manner: First, he tied the eye up tightly in a strong leathern purse, whose mouth he had slipped well over the ball. Then, having made an incision at the inner canthus, below the upper lid, he pressed the eyeball downward and cut around it, including the optic nerve in the incision, with a specially constructed knife. When the eye had been taken away, he strewed into the cavity a styptic powder, filled the cavity with lint and bandaged. The patient made an excellent recovery. (The first to remove the entire eye was Bartisch, q. v.)

Fabricius seems to have been a man of the highest moral character. All his contemporaries speak well of him in this respect. He was also very pious. His motto, engraved on a copper plate, was "Omnis tutela a Deo."

He died of gout and asthma, after a very long illness borne patiently, Feb. 14, 1634 (1619?).—(T. H. S.)

Face of prism. That surface of a prism which is designed to reflect or refract rays of light.

Face powder ophthalmia. Face powder has its dangers the same as gunpowder. For several years occasional cases have come under the observation of oculists in which the patients, invariably women, complain of vision being blurred, inability to use the eyes for any length of time and severe itching of the lids. The slightest rubbing of the lids produces a marked redness of the eyes and only aggravates the itching. In severe cases the lids are frequently swollen from constant rubbing. There is a sticky, elastic secretion which, when being removed, pulls out in long strings. Microscopic examination of the secretion reveals masses of what appear to be crystals. Until recently, as stated in a *Bulletin of the A. M. A.*, no satisfactory explanation of the presence of these crystals in the eye has been given. Secretion taken from the eyes of two sisters suffering from this peculiar complaint were submitted to the professor

of pathology of one of the university medical schools, who found that the crystals came from rice face powder. Seven other patients in whom the same symptoms and microscopic conditions were found all used the same make of face powder. When the powder is applied to the face with a puff a portion of the fine dust is driven upward and lodges on the moist eyeball. The rice powder in the presence of the tears then becomes mucilaginous in character and is not washed from under the eyelids. The powder produces the irritation, which is aggravated by rubbing. Those who use a chamois-skin in applying the powder are less liable to cause the fine dust to arise, which probably accounts for the condition not being found in every woman using face powder. The condition is quickly relieved by flushing the eye with boric acid solution. The irritation rapidly disappears when the eyes are kept washed out with a soothing eye-wash. See, also, **Conjunctivitis, Face-powder.**

Face-rest, Kallmann's. This is a device for preventing children from stooping over their desks at school and, presumably, increasing their myopia. Cohn speaks highly of it. He says: "I never allow my own children to write without it, whether at home or in school, even when sitting at the best possible desk." It is screwed to the desk, and causes little, if any, annoyance. The introduction of this rest for all children with tender eyes, both at school and in their homes, is worthy of commendation.

Facet. In biology, a segment of the compound eye of an insect. In ophthalmic surgery a flat, transparent or opaque area (scar) in the cornea. See **Cornea, Ulcer of the.**

Fächer. (G.) A fan.

Fachite. (It.) (Obs.) Phakitis—inflammation of the lens.

Facial expression in ocular affections. As assistance in making a diagnosis of ophthalmic diseases, facial appearance and characteristics should not be forgotten. They should especially be kept in mind in a preliminary examination of the eye. Many writers have emphasized the value of this method of investigation but it is difficult to define it. Oliver (*System of Diseases of the Eye*, Vol. IV, p. 439) says that with the head twisted to one side in accordance with the axes of the principal meridians of the astigmatism, the general attitude, and the mental characteristics of the subject; such as, for example, the peculiarities shown in the selection of dress-material, wall-paper, carpet, furniture-coverings, etc., evince not only the presence of some form of ametropia, but, to an observant clinician of experience, give a clue to the type of the special disorder. For example, the half-nipped eyelids of the astigmatic myope in his endeavors for distant vision are

in contrast with the widely-opened palpebral fissures of the corresponding hypermetrope.

Facialgebiet. (G.) The area of distribution of the facial nerve.

Facialis. (G.) Facial nerve.

Facialiskrampf. (G.) Spasm of the muscles supplied by the facial nerve.

Facialislähmung. (G.) Paralysis of the facial nerve.

Facial nerve. Seventh nerve. This is a pure motor nerve, whose nucleus is in the floor of the fourth ventricle beneath the superior fovea. It appears at the upper part of the medulla in the groove between the olivary and restiform bodies, close to the lower edge of the pons. Outside of it is the auditory nerve with a strand, the *pars intermedia of Wrisberg,* arising in a nucleus beneath the inferior fovea and connecting with the auditory. The facial, auditory, and pars intermedia all enter the internal auditory meatus together. At the bottom of the meatus, however, the facial parts company from the others and enters the aqueduct of Fallopius, following the windings of the canal through the temporal bone to the stylo-mastoid foramen. In the canal it gives off two important branches, the chorda tympani, which seems to be a taste nerve, and unites with the lingual branch of the fifth to innervate the anterior two-thirds of the tongue, and the branch to the stapedius muscle. After its emergence from the skull, the main trunk of the nerve passes downwards and forwards through the parotid gland and terminates by dividing just behind the ramus of the jaw into the *temporo-facial* above and *temporo-cervical* below, each of which sends numerous branches to the side of the head, the face and the upper part of the neck. As these branches intercommunicate freely, they form a sort of a plexus which is often called the *pes anserinus.* As the muscles to which these filaments go, namely, the buccinator and all those of the face except the muscles of mastication, play so prominent a rôle in expression, the facial is sometimes called the "artist's nerve."

The nerve, then, is distributed to the muscles of the scalp, of the external ear, nose, mouth, eyelids (excepting the levator palpebræ superioris) and to the platysma. It also supplies the muscles of the tympanum, the levator palati and azygos uvulæ (through the large superficial petrosal) and the stylo-hyoid and the posterior belly of the digastric.—(Mettler.)

Facial neuralgia. See **Trigeminal neuralgia.**

Facial paralysis. Bell's paralysis. Seventh nerve paralysis. Facial or Bell's palsy. This lesion of the facial nerve may be basal,

fascicular or nuclear. The condition is fully described on p. 926, Vol. II, of this *Encyclopedia*.

To this may be added some practical observations. For instance, Dutoit (*Archiv f. Ophthal.*, p. 145, Vol. 86, 1914) reports the following case of Bell's palsy:

A motorcyclist, colliding with an automobile, was picked up unconscious, and bleeding from the left ear. He was subconscious for 48 hours and showed a peripheral total paralysis of the left facial nerve, which after about a month began to subside. During his illness the following phenomena were observed: After two days the patient could close the lids sufficiently if he forcibly turned the left eye outward. Hasse has explained that a patient with peripheral paralysis of the facial nerve can occasionally lower the paralyzed upper lid by a partly half unconscious, partly voluntary, relaxation of the levator. Hence, Dutoit concludes, that if the abducens receives an impulse of intention, and the third nerve yields to its antagonist, the levator as antagonist to the orbicularis (facial nerve) yields to the intention impulse of the abducens by passive relaxation. The resistance of the levator under natural conditions to closure of the lids seems superfluous in paralysis of the facial nerve. Therefore the indirect support by an impulse of intention, which stimulates the abducens, may also reach and incite the orbicularis.

Again, at the attempt to close the lids, the eye of the paralyzed side in Dutoit's case turned up; the other eye did not. The writer explains this by lack of tonus in the third nerve and the inclination of the eye to assume its position of rest.

To all this Leber adds that the involuntary raising of the eye at the attempt of closing the lids is simply due to the innervation of the raising muscles, always associated with the closure of the lids. In facial paralysis the increase of innervation of the orbicularis is transmitted to the simultaneous innervation of the raisers of the eye, so that the eye turns up while the palpebral fissure remains open.

The involuntary closure of the lids in laughing, with simultaneous involuntary raising of the angle of the mouth, is an indication of improvement in a peripheral paralysis of the facial nerve and suggests treatment by methodical exercises.

Dutoit explains the muscular crepitation, or dysacusis, in the ear of the paralyzed side by the paralysis of the stapedius muscle. From the lack of the regulating movements of this muscle the stapes is exposed, and yields to the slightest fluctuations of pressure of the labyrinthine fluid. He infers from this disproportion, which corresponds to a disturbance of equilibrium within the labyrinth, an unnatural excita-

tion of the terminations of the fibres of the cochlear nerve, which the patient perceives as noise.

The treatment of seventh nerve paralysis is discussed by Hecht (Wood's *System of Ophthalmic Therapeutics*, pp. 316, 317) as follows: In the rheumatic or neuritic forms (Bell's type) the paralysis is present and complete before any causal or abortive therapy can be thought of, much less applied. The damage has been done and subsequently requires symptomatic treatment.

When pharyngeal or parotid gland inflammations, middle ear or mastoid disease are known to exist, careful attention to these will reduce the liability to facial paralysis. Basal fractures and injuries to the nerve at its foraminal exit from blows, falls, or the obstetrical forceps, require surgical service.

It is a fact, but one not sufficiently known or appreciated, that a considerable number of facial paralyses get well without any form of treatment. Assuming a rheumatic basis upon which some cases are supposed to rest, a brisk saline purge, followed by the administration of salicylates and alkaline beverages for some days, seems rational. Locally, to the affected side of the face an alternating fine spray (or douche) of hot and cold water under some pressure will stimulate capillary circulation and thereby improve the tone of flaccid muscles. Gentle friction may be made an adjuvant to this measure, but massage by an experienced person should be reserved for the subacute and chronic stage when repair sets in. If counter-irritation is used at all, it should be by blisters or leeches applied not to the face, but to the nerve trunk in the region of the stylomastoid foramen.

Since the facial distortion is intensified with every effort at eating, smiling or talking, it should be the aim of the patient to keep the features as passive as possible, constantly correcting the exaggerated position of the cheek and mouth after eating, drawing the eyelid down to cover the eyeball, and wearing a light compression pad to ensure closure of the eye during the night and when out in dusty or inclement weather. Conjunctivitis and corneal ulcerations are not so likely to develop in an eye relatively well protected.

Immediately after the onset of paralysis, the muscles should be subjected for five minutes and less each day to the galvanic current, the anode being placed over the motor points of the affected side of the face, and gentle contractions made by anodal closure. It is well to discontinue electrical treatment after six months, for the reason that the severer type of cases, lasting beyond this time, show a tendency to develop contractures under long-continued stimulation. Strychnine,

in doses of gr. 1-60 to 1-30, three times daily by mouth, for a continuous period, is of service as a general tonic.

In two classes of cases surgical interference is indicated and seems desirable: (1) The congenital, which after an interval of two years shows little if any improvement, and (2) the chronic, which after one and a half to two years remain stationary. The operations contemplate an anastomosis of the facial with the hypoglossal or the facial with the spinal accessory. Spiller favors the former, and Cushing thinks well of the spino-facial operation.

Facial perception of the blind. See **Blind, Sixth sense of the.**

Facial spasm. BLEPHAROSPASM. See p. 1112, Vol. II, of this *Encyclopedia.*

Facial tic. This neurotic affection of the facial nerve, as Hecht (Wood's *System of Ophthalmic Therapeutics,* p. 351) points out, requires to be carefully differentiated from facial spasm before a prognosis may be ventured or treatment advised. The participation of the eye and eyelids in the two affections so alike in their external manifestations yet so diametrically opposed in respect to etiology and pathology, frequently causes confusion in ophthalmologic diagnosis and error in treatment.

Tic is a mental affection amenable to cure "if one can will to cure it." Spasm results from a material irritative lesion in any part of the facial nerve from its cerebral or nuclear origin to its terminal branches. The idea of the incurability of tic has prevailed for so long that the majority of cases, except for some feeble effort, remain untreated. This neglect is not justified, since some improvement may be afforded even the most refractory types, and in the milder forms, cures effected.

Although they have, on the whole, proven inert in reducing or controlling the convulsive movements, sedatives and hypnotics, such as bromides in large doses, chloral or the various preparations of opium, may afford some transient improvement. In this connection it may be observed that the tendency of "ticquers" to develop mental disturbance renders the use of heavy hypnotics in general and opium in particular inadvisable. A variety of other drugs, zinc valerianate, gelsemium, quinine, arsenic and cannabis indica, have from time to time been tried, with negative results.

Electricity, massage, facial douching in one form or another are to be discouraged except when they are known to exercise a good psychic effect, but mechanical devices to arrest the tic are valueless.

Hypnosis is credited with some good results, and suggestion during waking hours is favorably regarded, but as some authorities reflect,

"To encourage the patient and assure him of progress, to reproach or reprimand him on occasion, is to employ an integral and invaluable factor in all re-educational treatment of tics; but is this truly suggestion?" "Treatment by re-education" has through the effort of Brissaud, Meige and Feindel and others of the modern French school of neurology become a recognized method, requiring infinite patience and ingenuity on the part of the doctor and patient. One can only enunciate the principles, not the rules, that apply in this broad method. They are: (1) The value of motor discipline, the discipline of immobilization. (2) Mirror exercises, enabling close observation and direction of motor control. For instance, in tic of the eyelids the repeated rhythmical opening and closing of the eyes, the steadying of the lid in a half open or half closed eye, all of which exercises are to be done with the head in different positions, are of distinct value. In eyeball tic other maneuvers have been described (Meige), such as dissociating the movements of eyes and head; keeping the head stationary where the eye is made to slowly follow an object or conversely letting the head rotate in horizontal and vertical planes while the eyes are fixed.

These are but fragmentary suggestions of a method which to be highly effective must be individualistic in application.

Absolute rest in bed for all cases has been authorized by some observers as the best treatment, whereas others have found it doing far more harm than good. I can personally subscribe to the view that even much bed rest as a general measure is undesirable. Nine sleeping hours by night for a psychoneurotic individual and perhaps one or two hours of midday napping is very beneficial as a relaxant. If unusual nervous irritability obtains with marked obsessional phenomena in a run-down and anemic ticquer, then a rest-cure treatment seems indicated.

The wisdom of enforcing isolation in these cases should depend more upon the nervous and mental complex of the patient than upon the severity of the tic. Relative retirement, with appropriate diversion and an agreeable occupation, does more good in the average case. Rational psychotherapy in addition to motor discipline of the order mentioned rounds out the medical treatment of tic.

For a purely obsessive disease there can be no raison d'être in surgical treatment except in so far as it may subserve a psychotherapeutic purpose, in which event it seems more heroic than wise.

Facies hippocratica. A peculiar facies first described by Hippocrates as an indication of approaching death, but which may result from long-continued diarrhea. It consists in a sharp nose, hollow eyes, collapsed temples, cold, contracted ears, the lobes being turned out-

ward, the skin of the forehead rough, distended and parched, and the color of the face green, black, livid, or lead-colored. (Foster.)

Facies Hutchinsonia. The peculiar facial expression, described by Jonathan Hutchinson, caused by immobility of the eyeballs in ophthalmoplegia externa.

Facies leontina. FACIES LEPROSA. The disfigurement of the face in leprosy by the puffed, knotty thickening of the skin over the eyes, giving to it a wild, morose appearance.

Faciometer. A device for making such ocular and facial measurements as are needed for the adjustment of lenses.

Facodonesi. (It.) Trembling of the lens.

Facultative hypermetropia. A form of manifest hypermetropia in which objects can be seen accurately in the distance both with and without convex lenses, and without use of the convergence.

Fädchenkeratitis. Filiform or filamentous keratitis.

Fadenkreuz. (G.) Cross wires.

Fadenoperation. (G.) Thread operation, generally applied to Snellen's method of treating entropion.

Fadenpilze. (G.) SCHIMMELPILZ. The hypomycetes fungus.

Fadenwürmer. (G.) Thread worms.

Fahrenheit's hydrometer. A glass tube provided with a mercury counterpoise and having a standard mark on the stem and a scale-pan on the top. The hydrometer floats in the liquid to be examined, the specific gravity of which can then be deduced from the weight of the load that has to be placed in the scale-pan in order to sink the stem to the mark.

Faiblesse. (F.) Weakness.

Faim. (F.) Hunger.

Faisceau. (F.) Bundle; fasciculus.

Faisceau d'aiguilles. (F.) Needles arranged in bundle form—for tattooing.

Faisceau lumineux. (F.) Pencil of rays.

Faisceaux optiques. (F.) Optic tract.

Faith-cure. The system or practice of attempting or pretending to cure diseases by religious faith and prayer alone. Someone has said that "it differs from mind-cure, in that the faith-curers have no mind, while the mind-curers have no faith."

Faith-healer. One who practises the faith-cure.

Falce da distrazione. (It.) Myopic cornea.

Falce da supertrazione. (It.) Supertraction (q. v.) crescent.

Fallacia. (L.) An illusion.

Fallacia optica. Any visual illusion.

Fallopia. Next to Vesalius, the most important of all anatomists. See **Falloppio.**

Falloppio, Gabriele. He was also called Fallopio, Fallopius, Falloppia, Fallopia. This great contemporary and pupil of Vesalius, and, after that marvelous master, the most important of all anatomists, was born at Modena, Italy, in 1523. He studied at Padua, travelled in Greece and France, became professor of anatomy at Ferrara, then at Paris, and, finally at Padua. He was the teacher of Fabricius ab Aequapendente, who, in turn, became a teacher of William Harvey. Falloppio is said to have been just, modest, and gentle, but, on the other hand, he is also declared, at least by some, to have accepted gifts from certain convicts and then to have destroyed these poor creatures by poisoning.

In our especial field, Falloppio is to be remembered because of his having shown that the retractor bulbi muscle (Choanoides) does not exist in the human subject. This structure was described as a portion of the human ocular apparatus by Galen (who had really observed such a muscle in cattle, sheep and other large herbivora) and the error had been conscientiously propagated for more than thirteen hundred years.—(T. H. S.)

Fallot, Salomon Louis. A well known Dutch-Belgian military physician, who devoted considerable attention to ophthalmology. Born at The Hague, March 11, 1783, the son and grandson of physicians, he accompanied a series of military expeditions in his medical and surgical capacity, and at last settled down in Brussels as surgeon, and chiefly as ophthalmologist. He died Feb. 11, 1873, almost 90 years of age.

Fallot's ophthalmologic writings appear chiefly in the "*Annales d'Oculistique.*" The most important is entitled "Recherches sur les Causes de l'Ophthalmie qui Régne dans quelques Garnisons de l'Armée des Pays-Bas, etc." (Brussels, 1829), once possessed of a modicum of value, but long since superceded.—(T. H. S.)

Falscher Staar. (G.) False cataract.

False attribution (of ocular diseases and injuries). The assignment of an untrue cause to an actually existent injury or disease. See **Legal relations of ophthalmology,** in middle third of article.

False cataract. An obsolete term for an opacity in the axis of the visual rays, but not in the lens (e. g., in the cornea or the aqueous humor).

False heterophoria. See **Muscles, Ocular**; also **Heterophoria.**

False image. The image seen by the deviating or non-fixing eye.

False macula. This rather rare condition is occasionally seen, espe-

cially in strabismus. It is a very annoying complication after operation, as the patient may acquire diplopia, with its annoyances. The vision in such a case is poor, rarely more than 1/6. As Worth (*Squint*, p. 36) explains, in an old case of squint, in which the angle of the deviation has remained exactly the same for several years, and in which the suppression of the vision of the deviating eye is not profound, the mind sometimes learns to make full allowance for the faulty position of this eye. So that the eccentric image, formed in the deviating eye, is mentally projected to the same spot as the true macular image, formed in the normally-directed eye, and is blended with it. This false macula is merely a small area which has escaped the loss of function which has overtaken the surrounding part of the retina. The visual acuity of a false macula is never greater than the normal visual acuity of the region in which it is situated.

In a case reported by Angus Macnab (*Ophthalmic Review*, p. 94, March, 1911) a woman, æt. 40, had suffered from convergent squint when æt. 5, for which she had tenotomy of the left internal rectus. Subsequently the eye diverged to about 48°. At this date she was myopic. The deformity was reduced by advancement of the left internal rectus and tenotomy of left external rectus; 22° of divergence remained. Symptoms of homonymous diplopia were now obtained, which, being measured and adjusted to the operative effect, indicated a false "macula" in the temporal field. Monocular diplopia was not found.

False projection. As Landolt (*System of Diseases of the Eye*, Vol. IV, p. 17) very properly points out, it is by the aid of the muscular sense that we make our way about, and particularly by the aid of the *sense of the ocular muscles.*

The patient affected with *paresis of the left external rectus* will, then, suppose the object fixed to be so much the more to the *left* side, as he has brought more energy into play in order to reach it with the visual line.

If, guided only by the paretic left eye, he hastens towards an open door, he runs the risk of a collision with the left side of the door-frame. Hence the very characteristic *gait* of such a patient: instead of going straight towards the point of destination, he at first goes too much to the left, and it is only later, on perceiving his error, that he rectifies his course, often betaking himself suddenly to the opposite side, where the object actually is. For the same reason, he pours water to the left side of the glass; instead of dipping his pen in the inkstand, he puts it to the left side of the stand, etc.

This false projection, as it is called, necessarily takes place always in the direction of the normal action of the paretic muscle, exactly like the projection of the false retinal image which gives rise to diplopia.

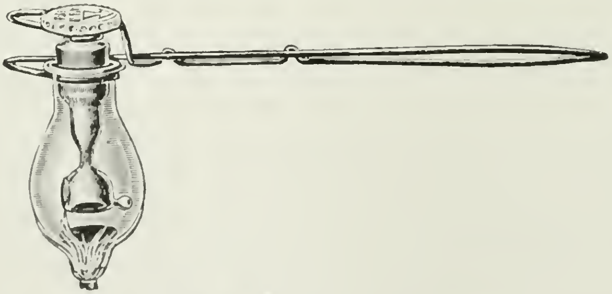
However, the two phenomena must not be confounded with each other. They are not at all identical. *Diplopia* is produced even when the eyes are at rest in their position of equilibrium, and results, as we have explained, from the comparison of the place in the retina where the image is formed in the healthy eye, with the one where it is produced in the deviated eye.

False muscular projection does not come into play until the moment when an effort is demanded of the paretic muscle. If, instead of directing the deviated eye towards the fixation-object, the patient displaces the latter or turns his head so that its image is received on the fovea centralis without any effort of the affected muscle, he will not be deceived as to the position of the object. Thus, the false projection *diminishes* in the direction of the *deviation,* while it *increases* in the direction of the *paretic muscle.*

Hence this pathological phenomenon to which the paralysis gives rise follows also from the physiological action of the muscle. To a person one of whose abductors is paralyzed, the ambient world will seem displaced towards the affected side. If it be the internal rectus that is paretic, the false projection will be towards the healthy side. In the same way, the hand will seem an object below its real position, and at the temporal side of where it really is, when the patient fixes only with an eye affected with paresis of the superior oblique.

False pterygium. That form of pterygium produced by burns, ulceration, diphtheria, etc. It may occur on any part of the globe, unlike the true growth that appears usually at the inner (though occasionally at the outer) canthus.

Falta's collyrium bottle. This useful little device is fully depicted and described in the accompanying figure and legend.



Falta's Collyrium Bottle.

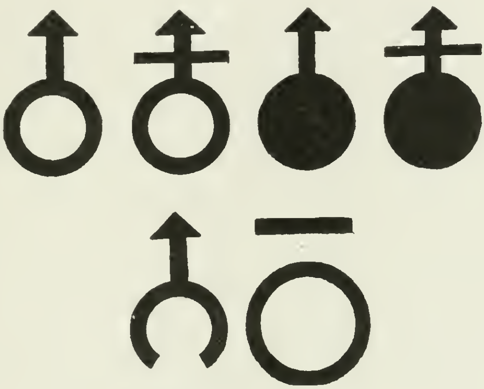
It is held over the flame, for sterilization, with a special wire holder.

Falte. (G.) A fold. A name given by Reil to the hippocampus minor.

Faltenkranz. (G.) Corona ciliaris.

Falz. (G.) A fold or groove.

Familial eye affections. FAMILY EYE DISEASES IN GENERAL. Although each of these peculiar diseases—in the strict sense generally hereditary—are or will be fully described under their proper headings, yet it is considered fitting to say something about several of them here. The reader is also referred to such captions as **Congenital anomalies of the eye**, as well as to **Hereditary diseases of the eye**, for additional information on the subject.



Familial Diseases.

Priestley Smith's Symbols for the Making of Pedigree Charts.

The best known examples of family eye diseases are certain forms of *corneal opacity; congenital cataract; choroiditis* and *chorioretinitis; amaurotic idiocy; buphthalmos; color-blindness; hemeralopia; coloboma; optic atrophy* (Leber's disease); *albinism; blue sclerotics* and *ataxia*.

In this connection Priestley Smith (*Ophth. Record,* Vol. XIX, p. 35) proposes for making pedigree charts the use of standard symbols printed on slips of paper. The slips which he has prepared are one inch square and the signs are illustrated in the accompanying cut. The interpretation of these symbols is as follows: The ring, with an arrow-head pointing upwards, means *male, unaffected.* The same, inverted, means *female, unaffected.* A black disc, in place of the ring, means *affected.* A line drawn across the stem of the arrow means *examined.* The omission of this line means *reliable evidence, but not examined.* A horseshoe instead of the ring means *no evidence as to*

affection; deletion of the arrow-head, *sex unknown;* a large ring or horseshoe with numeral, *so many of that kind;* the same with interrogation mark, *number unknown;* a horizontal line below a symbol, *no issue.* It is to be hoped that, in particular, writers on hereditary diseases or familial peculiarities will bear in mind and continue to employ these symbols, and so contribute to a most useful form of standardizing these observations.

Familial blue sclerotics. This peculiar affection has been fully described by many observers, especially by Bishop Harman. See page 1237, Vol. II, of this *Encyclopedia.*

Here but one instance will be mentioned, that reported by C. A. A. Drighton (*Ophthalmoscope,* April, 1912), a family of Welsh extraction showing blue sclerotics. Patient, aged 49 years, head of the present generation, had marked azure blue sclerotics, with slight hypermetropia of both eyes. He had fracture of both legs as a child, and in recent years fractured the olecranon of the right arm while swimming.

His father also had blue scleræ, but his father's two sisters had no sign of them. Patient is married; his wife, a woman aged 42, has not blue sclerotics. From this marriage there are seven children. Two daughters have blue sclerotics, and each had fractured legs from trifling causes. Of the five sons, four have blue sclerotics, and two of them had fractured bones.

See **Cornea, Family degeneration of the,** in which the familial form of *lattice-shaped opacity* is discussed.

Family coloboma of the iris. Tobias (*Klin. Monatsbl. f. Augenheilk.,* April, 1911) records an instance where a mother with bilateral operative colobomata of the iris gave birth to two children in a family of five with congenital colobomata of the iris and choroid. The oldest children had normal eyes. The operation had been performed four years before her marriage. In the right eye the coloboma was below and in, and in the left eye, up and in. The one, male child, which died in its first year, had bilateral colobomata below. The living, female child, 19 years of age, had a coloboma of the iris and choroid down and in.

Familial cataract. A family history of cataract including eleven persons is reported by Campbell *(Jour. Ophth. Otol. and Laryn.,* V. 17, p. 144, 1913). Two brothers and three sisters, aged respectively 30, 26 and 27 years, came to operation on account of diffuse lens opacities. The father of these patients had been operated on when under 30 years of age for cataract in both eyes which had developed two or three years earlier. He had five other children, all of whom

had developed cataract in previously normal eyes, and his sister and her daughter were affected in the same way. In every instance in which the history was clearly stated the lens change had been first noticed between the ages of 25 and 29 years. Excellent vision was obtained by operation in the three cases first mentioned. See, also, **Cataract, Hereditary.**

Family dislocation of the lens. The reviewer in the *Annals of Ophthalmology,* p. 538, July, 1912, furnishes an excellent abstract of the paper by A. R. Gunn (*Ophthalmoscope,* April, 1912) who records dislocated lenses occurring in a family through four generations. Eighteen were affected and nine were normal. Six affected individuals had been examined, three adults and three children. In the children the lens in each case could be seen floating free in the vitreous chamber. The vision in each case was markedly improved by + 10 D spheres. In the other members of the pedigree the histories clearly pointed to a similar condition, and the author assumes there was congenital aphakia due to dislocation of the lens, not improbably as a result of absence or imperfect development of the suspensory ligament. Each family contained both affected and unaffected individuals.

Examination of the pedigree shows at once that the condition is certainly not a Mendelian recessive; also that it affects both sexes in equal numbers. In two families with four and two children, respectively, it seems to behave as a pure dominant; in all the others there are both affected and unaffected individuals, the former preponderating. The only unaffected individual who has a family, it is interesting to note, has all his children (four) unaffected. We may assume, then, that the normal condition is recessive to the abnormal, and that, therefore, the latter probably differ from the others, not in lacking something essential to complete development, but rather in possessing some additional character or factor in virtue of which the normal development of the suspensory ligament is interfered with. On this assumption, and owing to the fact that the majority of the families contain both affected and unaffected individuals, we must regard the affected individuals as heterozygous for this inhibitory factor. Assuming, further, that each marriage has been between such a heterozygote and a homozygous normal, which we are justified in doing in the absence of any history of cousin or other interrelation marriages, we should expect as a result an equal number of affected and of unaffected offspring. The actual results, however, show a large preponderance of affected individuals. Tabulating the offspring of the union of an affected with a nonaffected parent, we find as follows:

Affected.	Nonaffected.
4	1
4	1
4	0
3	3
2	0
—	—
17	5

The total of the five such families is twenty-two, viz., seventeen affected and five nonaffected individuals, a result suspiciously like the 3 to 1 simple Mendelian ratio. Further, on examination of the individual families, it is curious to find two containing (1) members which apparently throw off only affected individuals when married to a normal recessive; (2) members which throw off both recessive and dominants, in one instance, in equal numbers; and (3) one member at least breeding true to the recessive character. Such a result, however, is not in this instance found in association with the union of two heterozygotes, and at present we must regard its significance as unknown.

We are justified, however, in tentatively concluding that (1) normal is recessive to abnormal, and (2) the individuals exhibiting the latter condition are heterozygous in composition for a certain factor in presence of which the usual development of the suspensory ligament of the lens is inhibited.

But what is this inhibitory agent? Two hypotheses suggest themselves: (1) the suspensory ligament may become ruptured after its formation, a suggestion the advanced development of the lens lends some color to, although, on the other hand, the exact nature and mechanism of the etiologic factor on this assumption is difficult to conceive, or (2) it may be prevented from forming at all. In an early stage of development the lens vesicle practically fills the optic cup, which afterwards, in virtue of its more rapid increase in size, grows away from it. But it is during this stage of contact that the cellular adhesions between the equator of the lens vesicle and the ciliary body, described by Treacher Collins as the mode of formation of the suspensory ligament, occur, and anything which would interfere with intimate contact until the increase in size of the optic cup became pronounced, would, of course, render difficult the formation of a functional suspensory ligament. Such a condition would seem to be fulfilled by an undue persistence of that portion of the intruding mesoblast known as the posterior fibrovascular sheath, although the com-

plete development of the iris and the clinical absence of any remnants indicate that such a persistence could not have been unduly prolonged.

Familial choroiditis. Doyne's choroiditis. Honeycomb choroiditis. R. W. Doyne (*Ophthalm. Review*, July, 1910) describes several cases (in addition to those previously reported) in which the changes were mostly observed in the region of the disc and macula, but in other cases showed the margin of the disc mainly or solely affected, while, on the other hand, the macula in some cases was the only part where the condition was found. In one of the cases there was a white spot, partly on the disc, showing that these areas were exudates, and not of atrophic origin.

He remarks that family choroiditis appears in early adult life, though more commonly later. It may affect either the disc neighborhood or the macula region, or both. It consists of circular patches of exudation, which increase during middle life, and at last set up some irritation and pigmentary disturbance, for, though pigment is not always present, in some cases there is a good deal to be seen. During this stage the sight is not much affected, but in old age there is optic atrophy with corresponding failure of vision.

Lutz (*Klin. Monatsbl. f. Augenh.*, p. 699, 1911) has described a form of family choroido-retinitis somewhat resembling that reported by Doyne. The family consisted of nine children, six girls and three boys; of these four girls were affected. Both parents were seen, and were unaffected; on the father's side all the antecedents for two generations had had good sight; on the mother's side nothing was known of any eye affection, but the data were not so full; there was no consanguinity. In all cases the disease began in the 11th or 12th year, and was of rapid onset. Both eyes were affected. Within a few months the vision was reduced to $^3/_{60}$—$^1/_{60}$. The fundus changes were confined to the posterior pole, and consisted of very fine, pale, yellow-gray dots, with minute pigmented spots between. In places there was some confluence of the spots into larger areas. Nerve and vessels normal. Light sense reduced and no evidence of tubercle or syphilis.

Collins (*Ophthalmoscope*, Vol. II, p. 537, 1913) gives the microscopic details of a case of Doyne's choroiditis. In the region of the macula and optic disc a layer of hyalin extended between the retina and the choroid, from near the margin of the disc inward for two disc diameters, and outward for six. Its inner surface presented several rounded elevations. Over the layer of hyalin the internal capillary layer of the choroid was much thinned, and in places absent. The outer layers of the retina in the same region were extensively dis-

organized. The primary change appeared to have occurred in the pigment epithelium. In a case recorded by Weiss (*Woch. f. Therap. u. Hyg. d. Auges.*, Vol. 17, p. 4, 1913) the whole fundus of the right eye showed the choroidal vascular system as a network of yellowish-white cords. The patient had seen poorly with this eye from early childhood.

See, also, p. 2143, Vol. III, of this *Encyclopedia*.

Family retinal diseases. Several retinal affections are found in members of the same family. For example, Zani (*Ann. di Ott.*, XL, 1912, p. 236) reports cases of retinitis punctata albescens in a brother, aged 12, and a sister aged 6, all who were affected out of a family of five. There were hemeralopia and lowered vision, and white dots in the fundus. In the boy's eyes the white spots were seen in the periphery and about the disc; in the girl's they were finer, and only in the periphery of the retina. Oguchi (*Ann. of Ophth.*, LXXXI, 1912, p. 109; *Ann. of Ophth.*, XXI, 1912, p. 562) reports three cases resembling this condition, showing hemeralopia, but instead of isolated whitish specks a diffuse grayish-white discoloration of the fundus. The optic nerve and vessels were normal, the macula appeared unusually dark. A similar case has been reported by Kusama (*Klin. Monatsbl. f. Augenh.*, April, 1912, p. 500), who calls the condition Oguchi's disease.

Ballantyne (*Ophthal. Review*, Dec., 1909) gives a review of a paper by Stargardt (Graefe's *Archiv. f. Ophthal.*, 71, 3, 1909), who has described a hitherto unrecognized *progressive family degeneration in the macular region.* The patients are members of two families. The first (family H.) consists of four persons, all affected; while the second (family N.) consists of five persons of whom three are affected. The parents in each case were quite healthy. The ages of the patients at the time of observation were from 12 to 20.

The condition affects brothers and sisters whose parents are healthy and give no evidence of ocular disease. There is no history of eye disease in the family and the parents are not blood relations. The visual defect first makes itself felt about the 12th to the 15th year and progresses steadily, though apparently very slowly at the beginning and end of its course. The defect involves the central vision. In the earliest period there is a central scotoma for red and green, later a relative scotoma also for white and the other colors, and finally total loss of central vision.

The striking fact that the patients could all write well, in spite of reduction of visual acuity to the counting of fingers, shows that the defect had not been congenital but must have come on after some years of school life. The peripheral field of vision is always normal both

for white and for colors. Color-vision is normal and there is no disturbance of the light sense or power of adaptation. It is possible that the macular changes begin before subjective loss is noticed, but in one case at least the defect was present subjectively before any changes were visible.

The disease is essentially one of the macular region, although the complete picture includes changes beyond the limits of that area.

In its earliest form we find a certain irregularity of pigmentation in the macula, and some yellowish-gray spots in that region scarcely contrasted with the fundus. At the same time there is loss of the foveal reflex. At a later stage small yellow or orange spots appear, which may coalesce to form larger ones, but they are always small and only visible in the erect image. At this stage small amorphous spots of pigment are scattered over the affected area. Both the foveal and the macular reflex are lost. The yellow spots spread over a môre extended area while the changes at the center become more intense.

The foveal change may take the form of a dirty grayish-yellow spot one-third of a disc diameter surrounded by a pigment ring, or of an orange-yellow spot of circular shape surrounded by a gray line sharply defined on its central side but gradually fading off towards the periphery (this form resembles the "macular holes" of Haab), or there is a deposit of dense amorphous pigment masses at the center, while in some cases we may see choroidal vessels shining through. In one case, at this stage, there were at the center fine white specks like those of albuminuric retinitis with fine white streaks radiating from them to beyond the limits of the affected area. In the same case there were a few individual "bone corpuscle" clumps of pigment.

Finally a somewhat sharply-defined area is formed at the macula, horizontally oval, with a diameter of 1½ to 2 disc diameters, its edges pigmented, its base of dirty yellowish-grey color, covered with fine amorphous pigment masses, and with a few greyish-yellow choroidal vessels showing through.

In all cases except the earliest there were also some small white spots, only visible on direct examination, something like those of retinitis punctata albescens, and probably situated in the deeper retinal layers; either confined to the neighborhood of the macula or extending as far as the larger vessels, or even beyond the disc. The fundi were otherwise normal, with the exception of slight temporal pallor of the discs in the later stages, and there were no other eye defects, no general disease or congenital anomaly, and no past illnesses of any significance. One notable feature is the very close resemblance of the changes in the two eyes at all stages.

The disease apparently begins in the "foveola" and ultimately affects an area wider than the limits of the macular reflex. In many cases the appearances suggest complete atrophy of the retina at the macula. There is some doubt as to whether the primary change is choroidal or retinal; on the whole the facts seem to suggest the latter. The author thinks the condition is degenerative rather than inflammatory, and he points out that it is somewhat analogous to retinitis pigmentosa while it affects the part of the retina in which cones predominate. The proximate cause is probably a circulating cyto-toxin.

Familial optic neuritis. A complete account of this rare condition is supplied by A. van Lint and G. Kleefeld (*Annales d'Oculist.*, Vol. 152, August, 1914). It deals with a remarkable group of cases occurring in one sibship, of interference with the endocrinous secretions, but whether the thyroid alone should be impugned for the optic nerve changes—simple optic atrophy in two cases and slight neuritis passing to atrophy in the other case—it is not easy to tell from the data given. Further details would be needed, including a note as to the carbohydrate tolerance, before the diagnosis of dyspituitarism could be fully excluded.

In a family of seven, of whom three died of pleurisy between the ages of three and seven, and one at sixteen of pulmonary tuberculosis, were two boys and a girl in the order—Edmond, Josephine and Joseph. At the age of 21 Edmond presented marked defect of sight in each eye, counting of fingers at about five metres in each, seven years' history, with simple optic atrophy, macular areas normal, no choroiditis. Right field contracted nasally and above, left concentrically contracted, no central scotoma. Horizontal nystagmus, divergent strabismus, refraction 1.5 D. H. He looked puny, resembling a boy of 14; forehead large, hair dry and friable, no moustache or beard, only down; pubic and axillary hair slight; nails striate and brittle, teeth good, regular. Skin dry and rough; hands and feet cold; no actual skeletal deformity. Infantile genitalia, and on left side an imperfectly descended testis in the inguinal canal. Some pleurisy, aortic stenosis. Very nervous, emotional; intelligence normal; knee-jerks active, Babinski negative, cremasteric reflex absent, abdominal reflexes exaggerated. Height about 5 feet 3 inches.

Josephine at age of 16 gave a five years' history of failure of sight: R. V. = 1/50; L. V. = fingers at 1 metre; R. field contracted nasally and above; no central scotoma; divergent strabismus, no nystagmus; R. H. 2 D, L. H. 5 D; simple optic atrophy as in Joseph. Nails, teeth and skin and breasts were all normal, but hair was scanty and dry, hands small, forehead large, face moon-shaped, height 5 feet. Secondary

sexual characters developed at 13. Old pleurisy. Whole body shows abnormal development of cellular and fatty tissues. Nervous system normal, except for epileptiform tremors. Cold feet.

Joseph—at the age of 15 gave history of about six months' defect of vision, R. V. = fingers at one metre; L. V. = fingers at 2½ metres. R. field was normal, Left slightly contracted; no absolute central scotoma; alternating divergent strabismus; slight H.; slight optic neuritis of each with temporal segment in process of atrophy, edge of papilla softened; macular area normal. Height 5 feet, forehead large, moon-face, hair not very silky, slight moustache, thin down on face, no body hair, no pubic or axillary down; nails striate, teeth good. Genitalia still infantile. All reflexes exaggerated; intelligence mediocre. No signs of rickets.

In the antecedents two conditions were specially noted—adiposity or family myxedema and nervousness, and in discussing the etiology of the optic atrophy the authors think they have excluded the possibility of any pressure on the optic nerves by hypertrophy of tissues because a rhinoscopic examination was negative. They dismiss hypophysis conditions because the fields have shown no bi-temporal hemianopia and X-rays show in one case only—Joseph—a slight enlargement of the sella turcica. They then thought of some infection or intoxication but Wassermann reaction was negative, and the patients presented no sign of tubercle, nor was there any albumin or sugar in the urine. They next turned to the internal secretions. Slosse, of Brussels, had shown that in hypothyroidism there were definite changes in the nitrogenous metabolism, and a table is given showing the proportions of the different nitrogen compounds as found by him in Joseph's urine before and after treatment with thyroid, with those of a normal individual for comparison. The authors noted that there was no further deterioration of vision after treatment with thyroid tabloids was begun, while the fields of vision actually increased.

In hypothyroidism alteration of cornea, optic atrophy, neuroretinitis in a case very like Joseph's but where there is said to have been bi-temporal hemianopia from vicarious hypertrophy of the hypophysis (Sanesi), have each been recorded, while in hypersecretion retrobulbar neuritis, and secondary optic atrophy have been met with. Leber's disease usually affects several males, there is a short history, central scotoma with full fields. Coste had four cases of family optic atrophy with congenital narrowing of anterior segment of skull, explaining the compression of the optic nerve.

The authors say they cannot put their case under Leber's disease since the affection appeared in a family involving the sister in addition

to the two brothers, and that without previous occurrence in the family, while further the vision was altered without central scotoma but with retraction of the visual fields. In this latter connection, however, it is well to recollect that only in two-thirds of the cases of Leber's disease is there a central scotoma; the peripheral field is usually normal, but concentric contraction for white may occur; in 74 families (Hormuth) 72 per cent. had only males affected, and 28 per cent. had both males and females affected, while collateral inheritance—the type of inheritance in this pedigree—occurred in 32 of 71 families. In his Bowman Lecture, Nettleship concluded that there seemed to be some connection between early age of onset and the female sex in Leber's disease.

All cases of family optic atrophy present great difficulty in diagnosis and call for very complete examination and investigation.—(Review by W. C. Souter in the *Oph. Review,* p. 52, Feb., 1915.)

Familial optic atrophy. Leber's disease. Hereditary central retinitis (Cargill). Cargill (*Ophthalmoscope,* X, p. 62, 1912) thinks that the primary pathologic changes are in the retina. He points out that, as a rule, the sight remains stationary after a rather rapid initial onset, and improvement may be delayed for as long as one, two or even three years. Hence a hopeful and expectant attitude should be taken during that period.

Four cases are recorded by Mügge *(Zeitschr. f. Augenheilk.,* p. 236, Vol. 25, 1912) in two families. The first family consisted of five sons and one daughter. The first and third sons were affected. At the time of entering school vision was already much affected. At the age of 23 the discs were pallid, especially in the temporal halves. The right visual field showed a sector defect for colors above and a central scotoma. The left field was not taken. The other affected child began to have failing vision at 12 years. At the age of 19 there was characteristic pallor of the discs. The fields for color were slightly contracted. In both cases some permanent improvement followed treatment by strychnin injections. In the second family the two eldest out of three sons were affected. The eldest, 27 years of age, accidentally discovered poor vision in the left eye at the age of 17 years. Two years later the other eye began to fail. The patient became almost blind but after prolonged use of electricity steady improvement occurred. Vision equalled about 5/30. There was absolute central scotoma and contraction for color. The discs were white and the vessels contracted. The other brother, at 26, discovered one eye almost blind. Two weeks later the other eye became affected. In this case the discs were red-gray and swollen

with peripapillary edema. Later atrophy set in. See, also, **Leber's disease** and **Hereditary diseases of the eye.**

Family amaurotic idiocy. Tay-Sachs disease. This is a fatal and probably congenital disease, seen almost entirely in Hebrew patients. It exhibits itself in early life and few patients survive until the tenth year, although in the so-called juvenile form the symptoms may set in later, and subjects live longer. In nearly all the cases a white or gray ring is found in the fundus surrounding a red spot at the fovea.

Cohen and Dixon (*Journ. Am. Med. Assocn.*, May 25, 1907) are among the earliest writers to give a histologic report on the eye in amaurotic family idiocy. The globes were enucleated less than three hours after death and the only changes detected were swelling of the multipolar ganglion cells, displacement of their nuclei, retraction of the cell reticulum, occasional disappearance of ganglion cells, and the general disappearance of Nissl's granules. The appearance of dark granules by Weigert's stain in all the ganglion cells, the peculiar formation of the macula and fovea (there were six layers of multipolar cells at the macula on the temporal side and eleven on the disc side, doubtless due to a fold in the macula), the so-called "spacing out" of the external reticular layer near the macula, and beginning simple atrophy of the optic nerve were also noted. Zenker's fluid is the best solution for fixing the retina; formalin the worst. Some at least of the finer cytologic changes may have occurred soon after circulation ceased. The arrested development theory of Sachs, the degeneration theory of Kingdom and Russell and the toxin theory of Hirsch fit together very well. If the central nervous system fails to develop properly the finer degenerations must follow, and it is only a step further to the development of toxins due to errors of metabolism.

One of the best reviews of this subject is furnished by Lawford (*Ophthalmic Review*, July, 1911) of papers by Carlyll and Mott (*Pro. Roy. Soc. of Med.*, Mar., 1911) and Gordon Holmes *(Ibid.)*. Eight cases are reported by these observers.

Seven patients (5 girls, 2 boys) were all children of Jewish parents from Russia or Poland. The families were not related. In two instances (case 1 and case 3) 2 children in the family were victims of the disease. In all the cases death occurred under the age of three years.

In the family of Case I, the fourth and fifth children were affected. Case II was the fourth child in the family.

In Case III, the first and second children were affected.

Case IV was the second child, Case V the fourth child, Case VI the third child, and Case VII the seventh child, of the respective families.

Higier's proposal to call the disease "Tay-Sachs," after the two earliest observers, has much in its favor—at least until its pathogenesis is discovered. Mott objects to the term amaurotic family idiocy, and has already pointed out that in the cases which have come under his observation, the brains were of normal size, or even larger than normal average, and also that the convolutional pattern was in no respect like that of an idiot's or imbecile's brain. He also noted that the superficial surface of gray matter, owing to the complexity of the convolutions, was by no means deficient in extent; neither was there a deficiency in the number of cells in the cortex cerebri, and, moreover, the characteristic change which is present in the cerebro-spinal ganglion cells is also found in those of the sympathetic system.

It seems, therefore, reasonable to conclude that the disease is an affection of the whole of the neurons of the body. It cannot be present long before birth, or the convolutional pattern would not develop to its perfect form.

Beyond the fact that the disease is limited to the offspring of Jewish parents, nothing definite is known as to its etiology. It has not been possible to associate it with any condition of food or environment; it appears to occur in both breast-fed and artificially-fed children.

In discussing the pathogenesis of Tay-Sachs disease, Mott is of the opinion that the pathological evidence shows that all the nervous units are present at birth, but from some cause as yet undetermined their vital energy is so deficient that they are unable to store any reserve of Nissl substance which many authors regard as the material basis of nervous energy; in consequence of this, the conductile mechanism (neuro-fibrils) undergoes destruction with morphological and biochemical changes in the neurons. As the neurons degenerate and die, the neuroglial cells proportionately proliferate and increase in size. and the consistency of the brain becomes tough and leathery.

The experiments of Verworn and others tend to show that the Nissl substance is a store of reserve neural energy and is contained in the mesh-work of the conductile neuro-fibrillary substance.

In Tay-Sachs disease there is a remarkable and characteristic disappearance of the Nissl substance taking place from without inwards towards the nucleus, and as the substance vanishes the cell swells as if a process of hydrolysis had occurred. In the later stages no Nissl substance can be seen upon the dendrons or in the greater part of the cell body which latter is often distended and distorted into an hourglass shape. The swelling and distortion of the cell is generally proportional to the disappearance of the Nissl substance.

Chemical analysis does not throw much light upon the question: the

diminution of the lipoid forms of phosphorus and sulphur is probably due to the diminution of myelin owing to the failure of development of the myelinated fibers. The corresponding increase of extractive forms of phosphorus and sulphur may possibly be due to a breaking down of the more complex to simpler forms of lipoids.

The morphological changes are quite characteristic of the disease. All the ganglion cells stained with Scharlach in degrees of intensity which vary in proportion to the degree of swelling and obvious morphological change; they also stained with all the methods which stain the myelin sheath or fat. They did not, however, stain satisfactorily by Marchi, like degenerated myelin does when the process of decomposition to choline, glycero-phosphoric and oleic acid has been complete. Consequently, it is more correct to say that the cytoplasm may be on the way to this complete decomposition.

In advanced cases there are immense numbers of cells containing coarse ruby-red globules of stained fatty substances; they are neuroglia cells which have taken up the fat from the dead and decayed ganglion cells. It is probable that they have the power of decomposing this lipoid of the dead ganglion cells, and possibly, of recomposing nuclear substance necessary for proliferation out of it.

Other methods of staining show that the intra-cellular fibrils are ruptured and destroyed by the swelling, leaving only the peripheral neuro-fibrils which can be followed from the dendrons in their course around the swollen cell to other dendrons, or to the axon.

The cells of the retina, when this structure is stained with Scharlach, show a similar change to the nerve cells of the central nervous system.

In two of the three brains examined, there was an accumulation of granulation cells along the course of the blood vessels; also endothelial and connective tissue cells of the peri-vascular sheath could often be seen filled with the dark, red-stained fat globules.

Any one of the methods employed for demonstrating neuroglia shows a numerous overgrowth of fibrils, especially in the superficial layers, where it forms a dense felt work—both in the cerebrum and the cerebellum. This overgrowth is proportional to the duration of the disease.

Holmes describes the pathological appearances in a case which, without reasonable doubt, was an example of Tay-Sachs disease, although unusual in some respects. The clinical record is incomplete. The child died at the age of 2 years and 10 months and was the brother of one of Carlyll's cases (No. III). The brain, portions of which were sent to Holmes, was found to be abnormally large, weighing 1,450 grm. and was very firm and hard to the touch.

The gyri of the portions received were well developed, and the attached portions of the meninges were apparently normal. The cortex was well developed and broader than that of a normal child's brain. The folia of the pieces of cerebellum were very slender and wasted.

The changes in the cerebral cortex, found on microscopic examination, were identical with those in cases previously examined by the writer, and those described by Risien Russell, Spiller, Mott, Schaffer and others.

In this case there was an enormous increase of the neuroglial elements, both fibrillar and cellular, so that under a medium magnification, the tissue appeared as a dense felt-work of neuroglial fibrils. This sclerosis was on the whole greater in the superficial than in the deeper layers of the cortex.

This neuroglial proliferation was almost as pronounced in the white as in the gray matter, and it was undoubtedly responsible for the abnormal size and weight of the brain.

It is noteworthy that in the case of the sister of Holmes' patient, Mott found evidence of decided sclerosis.

Holmes considers that the cerebellar atrophy, which was a noticeable feature in his case, is not to be looked upon as an essential feature of the disease.

The *Ophthalmic Year Book*, 1909-1913, furnishes a number of abstracts of both typical and atypical cases and mentions the reports of Dupuy-Dutemps (*Ann. d'oculist.*, Feb., 1908), Apert (*Semaine Méd.*, July 15, 1908), and Buchanan (*Sec. on Ophth., Coll. Phys. of Phila.*, Oct. 15, 1908). Nettleship (*Trans. Ophth. Soc. U. Kingdom*, Vol. XXVIII, 1908) brings together a series of thirteen cases of amblyopia (congenital or arising in early childhood) accompanied by slight fundus changes, and attempts to trace their possible relationship to amaurotic family idiocy. He thinks that cases of this latter condition surviving the usual period, might present some such characters, and suggests that the factors of race and of diet should be carefully investigated with reference to their bearing upon these conditions. In some of these cases there was a history of great feebleness at birth; in others the amblyopia appeared, or might have begun, after an attack of measles or varicella.

A group of cases reported by Stock (*Klin. Monatsbl. f. Augenh.*, March, 1908) seems more closely allied to amaurotic family idiocy. These patients were two sisters and a brother, healthy until about six years old, and then becoming blind and idiotic. Later they developed the pigment changes of retinitis pigmentosa. Microscopic examination of the eyes showed primary degeneration of the neuro-epithelial struc-

tures of the retina, with secondary involvement of the pigment epithelium, and slight degenerative changes in the ganglion cells, although the nerve fiber and ganglion cell layer was not atrophic. In contrast with amaurotic family idiocy, Stock points out that these cases showed idiocy without paralysis; blindness was slowly progressive, with the clinical picture of retinitis pigmentosa; and the anatomic examination showed a primary lesion of the neuro-epithelium without optic atrophy.

Of other atypical cases Ferjukowa (*Klin. Monatsbl. f. Augenh.*, April, 1911, p. 524) reported the disease in a brother and sister in whom arrest of mental development and failure of vision began at 6 years. The fundus showed optic atrophy, narrowed vessels, specks of brownish-black pigment toward the periphery, some of them of bone corpuscle shape. There was hereditary syphilis. The cases suggest an approach to retinitis pigmentosa. Oatman (*Amer. Jour. Med. Sc.*, 1911, p. 221) saw a brother and sister whose sight and intelligence began to fail at 6 and 7 years. There was at first central scotoma, and vision gradually declined to perception of moving objects. The fundus changes showed a general similarity to those of the preceding cases. Gifford (*Ophth. Rec.*, XXI, p. 8, 1912), besides reporting the cases of a brother and sister similar to the above, and a family group of five cases with little tendency to progress, has collected a large series of more or less related cases. He proposes to call this the juvenile form of amaurotic family idiocy, in contradistinction to the typical or infantile form, or Tay-Sachs disease. Magnus (*Norsk. Mag. for Laegevidensk.*, LXXIII, 1912, p. 1598) reports a boy of 7 with defective vision and motor disorders with optic atrophy whose sister had died at 14 after suffering blindness, palsy, and dementia. Magnus also reports a case resembling typical amaurotic "family" idiocy (infantile type) occurring in a family of seven. The other six children were healthy. The parents were of old Norwegian peasant origin, without admixture of Jewish blood, were not related, and there had been no nervous or mental disease in their families so far as their records went. Ochi (*Nippon Gank. Zasshi*, Nov., 1912) reports, with microscopic study of the eyeball, a typical case of "Tay-Sachs disease," the first case reported from Japan. He found the usual degeneration of the ganglion cell layer and atrophy of the nerve fiber layer. Smith (*Boston Med. and Surg. Jour.*, March 7, 1911) reports two typical cases, one a first child, the other the seventh child, the oldest of the family having died of the same disease.

A family group, including three cases of the so-called juvenile form, is reported by Harbitz (*Arch. f. Augenh.*, V. 73, p. 140, 1913). The parents were healthy and had been married eleven years when the

oldest child was born. She continued well, with normal intelligence and sight, until she was 7. Then vision became impaired with central scotoma, and pale optic nerve. Later the field of vision contracted and she became completely blind. Mental deterioration began at 12 years old; she became epileptic and died at 13. The eyes were not examined, but the brain presented the ganglion cell changes of amaurotic family idiocy. The next child, a boy, was normal until 5 years old. and then ran a similar course, dying at the age of 9 years. Six years later another boy was born who continued healthy until he was 6 years old, and then became amblyopic in the same way, although still able to see in the periphery of his field a year or more later.

Speaking of *family affections of the optic nerve in general,* H. Frenkel (*Archives d'Ophtal.,* Nov., 1913):

(1) That just as there are numerous types of familial affections of the nervous system, so also are there of familial optic atrophies, the one main branch being hereditary and familial (type Leber), the other not hereditary but limited to a single generation. It is those of the latter type, giving the aspect of a primary and not neuritic atrophy which seem to have a certain tendency to be associated in the same individuals, with familial affections of the nervous system. The author has only been able to find one case of Friedreich's disease with hereditary atrophy and only one of Leber's disease associated with a familial affection of the nervous system, and that affection was only observed in one generation.

(2) Those affections of the nervous system reputed to rarely give rise to isolated optic atrophy (cerebral diplegia, Friedreich's disease) are often found amongst those which, in a hereditary or familial form are accompanied by atrophy of the optic nerve in several members of the same family. On the contrary, amongst the numerous affections which are frequently accompanied by isolated optic atrophy (tabes, disemminated sclerosis, etc.) few cases of the coincidence of both are to be found amongst many members of the same family.

(3) The non-hereditary familial affections of the optic nerve often start in infancy (Tay-Sachs, retinitis pigmentosa, simple atrophy). Possibly the severity of these cases that begin early partially explains the fact that they are not observed in several generations. The familial and hereditary affections of the optic nerve (type Leber) begin in youth or adult age and are more benign. In fact, from the point of vision prognosis is much more favorable in those familial affections which start in later life.

(4) Consanguinity appears to play an important part in the etiology of the familial association of cerebro-spinal and optic nerve affections.

(5) Infectious and inflammatory complaints appear to play no part in the affections here discussed. Leber's disease, a retro-bulbar neuritis, is foreign to the syndrome here considered. Frenkel approves of the term familial degeneration to characterize this syndrome.

(6) In Tay-Sachs disease familial degeneration affects both central and peripheral neurones. In this complaint the lesions of the macula are to be explained as primitive lesions of the centripetal retinal neurones. Analogously it might be reasonable to suppose that the optic atrophies under consideration might start in cellular lesions of the retina without any visible ophthalmoscopic change.—(E. E. H. in the *Ophthal. Review*, Dec., 1914.)

Family ataxia. Friedreich's disease—the so-called hereditary ataxia (see page 662, Vol. I, of this *Encyclopedia*)—has a distinct familial tendency and, as such, finds a brief mention here. See **Hereditary ataxia.**

To Stargardt's account Darier (*La Clinique Ophtalmol.,* Jan. 10, 1914) has been able to add personal observations of five cases of this rare malady carried over a period of twenty-five years. The affection begins in early youth and is in general insidious and progressive, but in some recorded cases (Lutz, Stirling) the onset has been sudden. In some cases at the start no ophthalmoscopic change is found while in others the fundus lesion makes its appearance before the vision is affected. In all cases central vision is affected. Both eyes are in general simultaneously and equally affected, but the rate of diminution of vision varies considerably. In the majority of cases the lesions have been confined to the macula, but in exceptional cases (three of Stargardt and two of Darier) lesions have also been found in the neighborhood of the papilla and in the periphery of the retina. It is obvious that as far as the eye changes are concerned these cases are similar to the amaurotic family idiot type, and Darier proposes to differentiate two types, i. e., familial macular degeneration with or without idiocy. He inclines to the view that the earlier in life the macula is affected the greater the chance of the cerebral functions being also attacked. How and why the lesions appear there is no evidence to show. Syphilis can be excluded apparently.

The author's new cases come from two separate families. In the first group two out of four surviving children were affected, both females. In the second group there were three affected out of seven, and these were all males. In two of these the lesions had extended considerably beyond the maculæ.—(E. E. H. in the *Oph. Review*, May, 1915.)

Familial crypophthalmus and ankyloblepharon. H. G. Goldberg

(*Annals of Ophthal.*, p. 583, July, 1912) has described this defect as occurring in five members of one family, and extending through four generations. Although the cases were only partial, it was thought proper to classify them among the ankyloblephara rather than epicanthus, because the partial obliteration of the palpebral space was apparently due to a perfect union between the lid margins instead of an overlapping with the production of a fold; the unusual distance of the puncta from the bifurcation, and because it was possible to restore a considerable portion of the space by elevating the tissue uniting the lid margins. It did not appear that any of the shortening operations suggested for the correction of epicanthus would prove of value in his case, but instead he contemplated the division of the united lid margins after transfixing them upon a lachrymal probe, the resulting surfaces to be joined by fine sutures.

Family eye diseases. See **Familial eye affections.**

Fano, Salvador. A well known Dutch-Parisian ophthalmologist, born at Amsterdam, Holland, in 1824. He received his medical degree at Paris in 1851, and, in that city, taught, investigated and practised until his death, in May, 1895.

He wrote: "Recherches sur la Contusion du Cerveau" (Paris, 1851; graduation thesis); "Des Tumeurs de la Voûte Palatine et du Voile du Palais" (1857, av. 2 pl.); "Mém. sur la Catarrhe du Sac Lacrymal, etc." (Paris, 1863); "Des Lunettes et de leur Emploi en Oculistique" (Paris, 1867); "Traité Pratique des Maladies des Yeux" (Paris, 1866); "Traité Elémentaire de Chirurgie" (T. 2, 1869-72).

From 1873 to 1882 he was editor of the *Journal d'Oculistique et de Chirurgie*.—(T. H. S.)

Fantascopy. One of the names for retinoscopy or skiascopy.

Fantoscopie rétinienne. (F.) Skiascopy.

Farad. The unit of electrical capacity.

Faraday, Michael (1791-1867), one of the most distinguished of English chemists and natural philosophers, was born at Newington Butts, near London, England, where his father was a blacksmith. Chance having procured him admission, in 1812, to the chemical lectures of Sir Humphry Davy, the latter engaged him as his assistant at the Royal Institution. In 1827 he succeeded to Davy's chair of chemistry in the Royal Institution.

Some of his chemical discoveries or investigations were: new compounds of chlorin and carbon (1821); alloys of steel (1822); compounds of hydrogen and carbon (1825); and the very valuable series of experiments, made in 1829-30, on the manufacture of glass for optical purposes. See **Glass, Optical.** As practical applications

of science his suggestions as to the preparation of the lungs for diving and the ventilation of lighthouse lamps are conspicuous. Amongst his most prominent publications are those concerning the condensation of the gases, limits of vaporization, optical deceptions, acoustical figures, re-gelation, relation of gold and other metals to light, and conservation of force.

The great work of his life is the series of *Experimental Researches on Electricity,* published in the *Philosophical Transactions* during forty years and more. These give an account of his many discoveries relating to electricity, magnetism, electro-magnetism, and dia-magnetism. Some of the most important of his discoveries are: induced electricity; identity of electricity from different sources; equivalents in electro-chemical decomposition; relation of electric and magnetic forces; hydro-electricity; magnetic rotatory polarization, and many others.—*(Standard Encyclopedia.)*

Farbengleichung. (G.) Color equation.
Farbe. (G.) Color.
Farbebild. (G.) The spectrum.
Farbenblindheit. (G.) Color-blindness.
Farbenbogen. (G.) The iris.
Farbendreieck. (G.) Helmholtz's color triangle.
Farben, Einfache. (G.) Primary colors.
Farbenempfindung. (G.) Color sensation.
Farbenempfindlich. (G.) Sensitive to color.
Farbenhören. (G.) Color-hearing. Color-audition.
Farbengleichung. (G.) Color equation.
Farbenkreisel. (G.) Color disc.
Farbenlehre. (G.) Chromatography. Treatise on color.
Farbenmachend. (G.) Colorific. Color-producing.
Farbenmessung. (G.) Chromatometry.
Farbennuancen. (G.) Color shades or tints.
Farbenoctaëder. (G.) Color octahedron.
Farbenproben. (G.) Color tests.
Farbenreiber. (G.) Color mixer.
Farbenringe. (G.) Newton's rings.
Farbenscheu. (G.) Chromatophobia.
Farbenscheibe. (G.) Color disc.
Farbensehen. (G.) Chromatopsia.
Farbensinn. (G.) Color-sense.
Farbensinnprüfung. (G.) Testing the color sense.
Farbensinnstörung. (G.) Disturbance or defect of the color sense.
Farbenspiel. (G.) A play of colors.

Farbenunterscheidungsvermögen. (G.) The ability to distinguish colors.

Farbenwerth. (G.) Color value.

Farbenzerstreuung. (G.) The dispersion of colored rays.

Farbestoff. (G.) Coloring matter, pigment or dye.

Farbige Gläser. (G.) Colored glasses.

Farbige Nachbilder. (G.) Colored afterimages.

Färbung. (G.) Coloration, staining.

Farcy. See **Glanders.**

Fard noir. (F.) A cosmetic in the form of a paste, powder, or pencil, having for its base lamp-black; used to blacken the eyelashes and eyebrows.

Fario, Leovigildo Paolo. A well-known Italian ophthalmologist. According to Hirsch's *Lexicon,* Vol. II, p. 339, he founded the *Annali Ottalmologici.* Born Nov. 16, 1810, at Asola, Italy, he studied at Padua, Pisa, Florence, Pavia and Bologna, practised at Venice, later (and longer) at Brescia, and died in 1863.—(T. H. S.)

Far point. The farthest point at which an object can be distinctly seen with suspended accommodation. In the emmetropic eye it is theoretically at an infinite distance; in the myopic eye it is in front and in the hyperopic eye it is theoretically beyond this, as the latter eye is adapted only for convergent rays.

Farre, Frederick John. A well-known London ophthalmologist, second son of the still more distinguished John Richard Farre. Born Dec. 16, 1804, he studied at St. Bartholomew's Hospital from 1829 to 1837. In 1834 he became Assistant Physician to the Royal London Ophthalmic Hospital, and also at St. Bartholomew's. In 1854 he was made physician to the latter institution, as well as to the Charterhouse. In 1838 he became a F. R. C. S. He wrote little if anything about the eye. He edited, however, the first edition of the *British Pharmacopoeia,* and Pereira's *Materia Medica.* Farre died at Kensington Nov. 10, 1886.—(T. H. S.)

Farre, John Richard. A celebrated London pathological anatomist and ophthalmologist, co-founder with Saunders of the Royal London Ophthalmic Hospital. Born in 1774, on the Island of Barbadoes, the son of a physician, he studied at Guy's Hospital and St. Thomas's Hospital, London, and practised for a time in the Antilles. Later, he practised in Glasgow, Aberdeen and London. He also became physician to the London Dispensary. He made an enormous collection of pathologico-anatomical specimens, which became the property of St. Bartholomew's Hospital. He died May 7, 1862, aged 88.—(T. H. S.)

Far sight. Hypermetropia.

Far-sightedness. A colloquial term for hypermetropia.

Fascetto. (It.) Bundle.

Faschia bulbi. A synonym for Tenon's capsule. See **Fascia, Bulbar** and **Anatomy of the eye.**

Faschia Tenoni. A synonym for Tenon's capsule.

Fascia, Bulbar. A name for the capsule of Tenon, which is derived from the fact that this capsule is really the lining membrane of a lymph cavity and has many communications with the intraocular space between the choroid and sclera. It is also supplied to the perineural space around the optic nerve and thence onward through to the dural sheath and sub-dural interspaces of the cerebral envelopes.

Fascia ocularis. Fascia oculi. (L.) A name given to an old form of bandage for retaining a dressing on the eye or to prevent the use of

Fascia Ocularis (Bandage).

the eye. A few horizontal turns with a roller are made around the head, then a number of oblique spiral turns over the eye, and finally a few additional horizontal circular turns.

Fascia, Oculo-orbital. A name for Tenon's capsule. See **Anatomy of the eye.**

Fascia, Oculo-palpebral. A name for Tenon's capsule.

Fascia, Orbital. Orbitoocular fascia. Synonyms of Tenon's capsule.

Fascia, Palpebral. The tarsal ligament of the eyelids. The same name is also applied to the subconjunctival tissue of the eyelids.

Fascia, Tarso-orbital. Septum orbitale. This fascia connects the tarsus with the margin of the orbit, and in the upper lid blends with the tendon of the levator palpebræ superioris.

Fascia Tenoni. Fascia tenonis. Tenon's capsule.

Fasciatura. (It.) Bandage.

Fasciatura protettiva. (It.) Protective bandage.

Fascicular keratitis. See **Keratitis, Fascicular.**

Fascicular palsy. Paresis or paralysis of nerves caused by a lesion situated somewhere between the cerebral center and their exit from the skull.

Faser. (G.) Fibre.

Faserbündel. (G.) Fasciculus.

Fäserchen. (G.) Fibril.

Faserkörbe. (G.) A name given by M. Schultze to the basket or cratelike appearance of the membrana limitans externa of the retina after the removal of the rods and cones. This appearance is due to the delicate terminal processes of the radial or Müllerian fibres extending outward from the external limiting layer to surround and support the rods and cones.

Faserkreuzung. (G.) A decussation of fibres.

Faserverlauf. (G.) The course of fibres.

Faserzug. (G.) A tract or bundle of fibres.

Fast colors. Colors are so designated that fade little or not at all under the influence of light, heat, water and ordinary exposure to wear and weather.

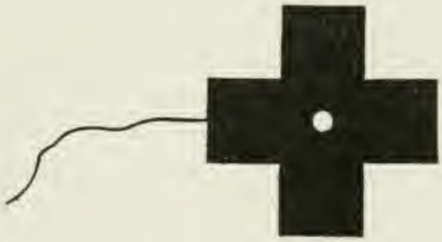
Fat-embolism. Fatty embolism. A condition sometimes observed as a sequence of fractures, consisting essentially in the passage into the veins of liquefied fat, which is carried into the lungs, brain, etc., blocking up the capillaries of those organs.

Fatigue. This theoretically important subject is closely related to the practical one of *eye-strain* (q. v.). Cattell (*System of Diseases of the Eye*, I, p. 526) says of it that when the retina is continually exposed to light, perception begins to fade, and finally loses its quality and may disappear altogether. The effects of fatigue may be seen by placing a small, black cross (see the cut), on a sheet of white paper to which a thread is attached. If after looking at the cross for ten seconds it be jerked away by the thread, a very white cross will be seen on the sheet of paper. The eye has become fatigued for the white excepting the part covered by the cross, which consequently appears the brighter. The same experiment may be made for colors by placing the black cross on a sheet of colored paper. The part which had been covered by the cross will look much more intense and saturated than the rest. In making such experiments a halo is usually seen about the cross, this being due to involuntary movements of the eyes. According to Fechner, a bright white light (as white paper in the sunlight) does not simply become less bright, but passes through a series of colors. The white at first looks yellow, then blue-green or blue, and finally red-violet or red. These changes in color are thought by Fechner to

be due to some of the components of white light producing fatigue sooner than the others.

Cattell further remarks that Hess has made a complete study of the appearance of spectrum colors after the eye had previously been fatigued for certain colors. He used nine points in the spectrum and two combinations of red and violet, and was able to obtain quantitative results. He thinks the alterations do not accord with the requirements of v. Helmholtz's color triangle.

If a small colored bit be placed on a sheet of gray paper it can be looked at until the color disappears altogether. As first shown by Maria Bokowa, fatigue amounting to color-blindness may be brought about by wearing spectacles with colored glasses, all side-light being cut off. Indeed, the same fact is illustrated by comparing our sensation on going from the daylight into a room lit up by gas or lamps with



Cross Illustrating Fatigue Experiments.

that which we have in the same room in the evening. In the former case the light seems reddish, in the latter we notice no color. Quantitative determinations of fatigue have been obtained by C. F. Müller in Fick's laboratory, by Exner, and by Schön. According to Müller, if the intensity of the original sensation be 1, the intensity after three seconds will be 0.72, after five seconds 0.66, after ten seconds 0.49, after fifteen seconds 0.46, after twenty seconds 0.43, after twenty-five seconds 0.37, and after thirty seconds 0.35. Fatigue consequently follows most rapidly at first, and more slowly afterwards, the apparent intensity waning to half in about ten seconds. Fullerton and the writer have found that when two lights are viewed in succession the second is apt to appear the fainter, the constant error being on the average one-twelfth of the light. Schön used colors of the spectrum and obtained results corresponding to Müller's. After three seconds red decreased to 0.59, green to 0.52, and blue to 0.37. The visual mechanism is most sensitive when we first awake in the morning. According to Müller, the sensitiveness decreases during the day, and objects appear only half as bright in the evening as in the early morn-

ing. If this were the case, the time of day should be considered in making tests for the sharpness of vision. Certain experiments by Fick and Grüber, however, show that fatigue reaches its maximum in three-quarters of an hour or less after awakening, and that so long as the light is kept constant no further decrease in sensitiveness occurs in the course of the day. These writers hold that the sensitiveness of the retina is restored by movements of the eyelids and of accommodation; but this view seems to be refuted by Hering.

G. Viale (*Annali di Ottalmologia*, xl, p. 669, 1913) has noticed that after one eye had been fatigued by exposure to strong light, colors seen with the other eye appeared much clearer. Thus, dark-green looked very bright, and yellow was greenish. In experiments in which the periphery of one retina (this part of the retina having only light sense) was stimulated, and the other retina kept at rest, the non-stimulated retina afterwards showed no change, either in light or color-sense. Therefore fatigue of one retina affects the color sensibility, but not the light sensibility of the other retina. Investigations by Monakow and others point to the existence of fibres passing between each retina and the anterior corpora quadrigemina, and to stimulation of the cones of one retina when light falls only upon the other. Hence the writer argues that, as the cones are the organ of color-sense, the change of color-vision which he has observed is due to reflex stimuli passing from one retina to the other by way of the anterior quadrigeminate bodies. See **Ferree-test.**

Fatigue-field. This term is commonly used to indicate the limits of the field of vision found in neurasthenics. The asthenopia of the neurasthenic may also show in the shifting field of Förster, in which the extent of the field is greater on that side where the test is begun, i. e., if we begin on the nasal side and cross over to the temporal side, through the fixation-point, the test-object will disappear on the temporal side nearer to the fixation-point, showing greater contraction on that side. If, however, we commence on the temporal side, we will find that side of the field will be the greater. In other words, the broader side of the field shifts.

Wilbrand's exhaustion test is practically the same confined to the horizontal meridian. Each repetition of the test in the same meridian reduces the field. The smallest field that can be obtained is called the "minimal visual field," and the largest the "maximal visual field." When the test is made with the white test-object, it is found that the fatigue for color is not affected as it is for white, and vice versa.

If a complete field is taken and repeatedly taken it becomes smaller and smaller, and a line connecting the points assumes a *spiral* form.

In the *oscillating visual field* of Wilbrand the test-object disappears and reappears, when moved radially, producing line-like scotomata.

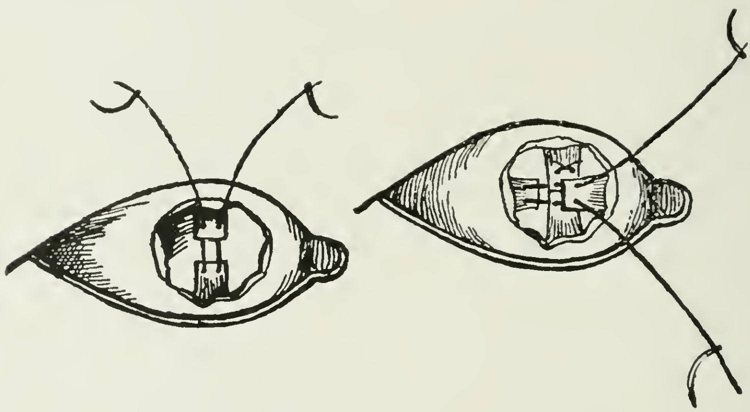
In explanation of the fatigue-fields, Wilbrand believes that the insufficiency of the retina is due to changed conditions of metabolism, affecting the external layer of the retina. Peters ascribes such fields to a disturbance of innervation in the transmission of nerve-stimuli from the retina to the optic tracts. Plazek thinks there is a blunting of the centre of consciousness. Simon believes that there is a fatigue of the psychic sphere. Schmidt-Rimpler believes that inattention and lack of the power of concentration account for the contraction of the visual fields.—(J. M. B.)

Fat implantation. The introduction of a fatty mass, from the abdominal or gluteal region of the patient, into the socket after enucleation of the eye has been discussed already on page 4446, Vol. VI of this *Encyclopedia*. To the account there given of that procedure it may here be added that Lauber's (*Ophthalmology*, Vol. VII, p. 148, 1911) method of fat implantation is to enucleate in the usual manner after transfixing each rectus muscle with a double-armed catgut suture. All hemorrhage having been checked, a mass of fat of sufficient size to fill, without overstretching, the capsule of Tenon is inserted. The excision of the fat from the abdominal walls is facilitated by making a right-angled incision in the skin. Care must be taken not to mutilate the fat and to check hemorrhage with ligatures. After the fat has been inserted the recti are sutured crosswise, then the capsule of Tenon is closed with catgut also, and finally the conjunctiva with silk. This method has been used in thirty-seven cases since 1908 with but six failures. In the course of the first two or three months there is a decided shrinkage of the implanted fat but from then on it remains unchanged. Marx (*Ophthalmology*, Vol. VII, p. 147, 1911) has used fat both in the scleral cup and in the capsule of Tenon. In the latter operation good results have been obtained without suturing the opposite recti. He believes that this operation deserves preference over other procedures, as extrusion never occurs and a prothesis never causes trouble.

In C. N. Spratt's cases (*Oph. Record*, Oct., 1913) he was much impressed with its advantages over the other substances suggested. By the use of fat, a sterile, autogenous graft is secured, which, when inserted in Tenon's capsule, has less tendency to change its position than any of the other substances suggested. It offers little or no chance for extrusion, unless an infection takes place, or faulty methods of suturing are used.

The method used by the writer is as follows: Warm ether vapor

is given through a tube in the nose, or by the intra-tracheal method. The skin about the eye is cleaned with alcohol, ether and oxycyanide of mercury 1:1,000, and the conjunctival sac is flushed with a solution of 1:3,000 of the latter. The face is covered by a layer of wet gauze. The conjunctiva is divided close to the limbus and dissected backwards, beyond the insertion of the recti muscles. These are picked up on a strabismus hook and separated from the surrounding tissue. Before dividing the tendons, each is caught by a small Halsted "mosquito." After dividing the tendons at their insertions, the eye is enucleated in the usual manner and the cavity is packed with a moist sponge, to stop the hemorrhage.



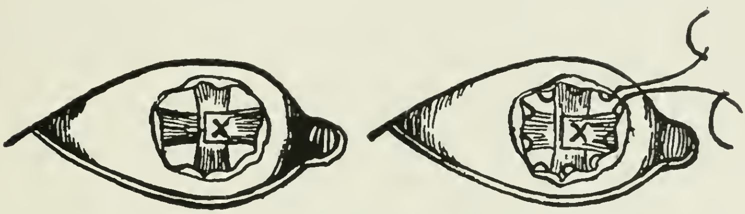
Implantation of Fat in Tenon's Capsule. (Pratt.)

After cleaning the skin of the abdomen, a horizontal incision 4-6 cm. long is made below the umbilicus and a piece of subcutaneous fat is removed. Even in thin individuals, there is a sufficient layer of fat for this purpose. A larger piece of fat can be placed in Tenon's capsule than can be inserted when of paraffin or glass, as the fat is more elastic and is not forced out between the muscles, as is a smooth, hard mass.

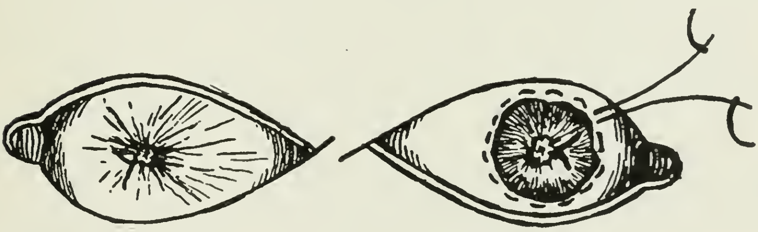
On removing the packing from Tenon's capsule, it will generally be found that the hemorrhage has ceased. The fat is inserted and the superior rectus is sutured to the inferior rectus by a mattress suture of double 00 chromicized catgut. The loop of the catgut is placed beneath the inferior, and the knot on the outer surface of the superior rectus. This makes the strongest possible suture. The two lateral recti are sutured in a similar manner, each needle being passed through the previously sutured recti. By this method a fixed point for all four muscles is formed.

When the sutures are being tied, an assistant approximates the ends of the muscles by means of the hemostats, thus preventing traction and cutting of the sutures. Tenon's capsule is closed over the muscles and fat, by means of a deeply placed catgut suture. This relieves the tension on the muscles, covers the fat with an extra layer of tissue and prevents the fat from protruding between the muscles.

The conjunctiva is closed by another purse-string suture. A firm pressure bandage with a thick layer of soft gauze is applied. This is rather uncomfortable, but its use is advised, as, with it, the swelling is less and convalescence is shortened. The incision in the skin of the abdomen is closed by subcutaneous sutures.



Implantation of Fat in Tenon's Capsule. (Pratt.)



Implantation of Fat in Tenon's Capsule. (Pratt.)

Less swelling has followed the use of fat than formerly occurred when paraffin was used. An artificial eye was used in Spratt's three cases, at the end of 18 to 24 days.

The movements of the stump have been excellent, the average being: 28° upwards, 15° downward, 22° nasalward, 20° temporalward. According to Reber, the average rotation in 100 normal eyes, was, upward 36°, downward 52°, nasalward 50°, temporalward 48°. After the swelling, due to the trauma of the operation, has disappeared, there is an apparent shrinking of the contents of the orbit. Unquestionably, there is some atrophy of the fat, but it has not been found to be as great as that reported by Weidler, who states that, in his cases, there was apparent shrinking to 1/2 to 1/3 of the original size.

Pratt draws the following conclusions: 1. The aim of the surgeon should be to obtain a good, movable stump after an enucleation. 2. Fat, being an autogenous graft, is least liable to be extruded, as it becomes a living part of the orbit. 3. Fat can be obtained in a sterile condition and forms a soft, elastic mass that is non-irritating and will not slip its position as do smooth, hard, foreign bodies.

H. S. Gradle (*Arch. of Ophthal.*, p. 154, March, 1915) tabulates 29 cases of enucleation and 54 cases of evisceration with fat implantation. Of the 29 enucleated cases the fat was extruded in two, and of the 54 cases of exenteration, the fat was extruded in six. Gradle considers an acute infection of the coats of the eye to be a distinct contraindication to the implantation of fat. In half the cases the implanted fat had shrunken to about one-half the original amount. This, the author states, can be counteracted by injecting sterile vaseline into the stump.

Fäulnismicrococcus. (G.) Infective organism.

Fäulnisshemmung. (G.) Measure intended to prevent putrefaction or infection.

Faure. A celebrated quack of the early nineteenth century, ophthalmologist to the Duc de Berry. He wrote a work, no longer extant, entitled "Description graphique des Yeux de Plusieurs Aveugles Jugé Incurables qui ont Recouvré la Vue au moyen d'un Instrument et d'un Procédé Inventé par l'Auteur" (Paris, 1820); and another, entitled "Observation sur l'Iris," in which he pretends to have invented the operation (already old) called "Discission of the Lens." —(T. H. S.)

Fauteuil à opérations. (F.) Operating table.

Favus. Ringworm. See page 60, Vol. I, of this *Encyclopedia*. In addition, Parsons (*Pathology of the Eye*, p. 8) says that very few cases of favus of the lid are on record, but its occurrence is probably more frequent than the paucity of reported cases would lead one to expect. The disease commences with the formation of yellowish-red vesicles, and rapidly goes on to the formation of a bright-yellow crust, which is very characteristic. He examined one case, and there was no difficulty in demonstrating the *Achorion Schönleinii*. The patient's cat was also examined, but without result, though the source of the disease in cats or mice has been almost certain in some cases.

Fawcett, Henry. "The Blind Postmaster-General." He was born at Salisbury, England, Aug. 25, 1833, of parents who were both well-known political economists. He attended King's College School, London; and, later, at Cambridge, became seventh wrangler (1856) and was elected to a fellowship in his college. Soon after he began to

study law he lost his sight by the accidental discharge of a gun in the hands of his father.

After this occurrence, he abandoned the study of the law, and began to specialize in political economy. He gave a rather large number of lectures on political science, and in 1863 published his "*Manual of Political Economy.*" As a result of this scholarly production, he was elected to the chair of Political Economy at Cambridge.

In 1865 he was elected to Parliament. At first he was a follower of Gladstone, but later (in 1873) by his bitter opposition to the Irish education scheme, he contributed not a little to the defeat of the Gladstone ministry. In 1880, however, when the Liberal party had been restored to power, Gladstone made Fawcett postmaster-general. In this position the great, blind man was an ardent reformer. The parcels post, money orders, stamp-banking, the table of "Hours of Collection" on pillar-boxes, and numerous other improvements were due to his executive ability and genius.

He wrote a large number of books, was made an honorary D. C. L. of Oxford, a Fellow of the Royal Society, and Lord Rector of Glasgow University.

He was a man of impressive appearance, six feet four inches tall, lean and lithe, and very quick and active. Prior to his blindness, he is said to have been somewhat overbearing in his manner, but, after that terrible calamity he was kind and gentle to a fault.

He died Nov. 6, 1884, of congestion of the lungs. He was buried at Cambridge, but a monument has been erected to his honor in Westminster Abbey.—(T. H. S.)

Faye, George de la. This distinguished French ophthalmologist was born at Paris, in the Faubourg du Roule, Oct. 10, 1699. The son of a well-known surgeon and the nephew of the Surgeon-Major in the Military Hospital at Berg-Saint-Vinox, he began to study surgery with his uncle at the age of about fifteen. With the uncle, however, he remained only for three years. Returning to Paris, he entered the Charité as a pupil of de la Peyronie, but shortly afterward became an interne in the Hôtel-Dieu. In this capacity he labored at the celebrated institution for more than ten years—until, in fact, 1730. The year following, he received the degree of master of surgery. Almost immediately thereafter he became assistant-surgeon (aide-major) in the army, in which position he served throughout the siege of Kehl.

Returning to Paris, he entered into private practice, and though he wrote and published much, and invented many useful instruments, he never became again attached to a public institution until, in 1742, he accepted the position of Demonstrator Royal of Operations. In

1751 he was elected Vice-Director of the Royal Academy of Surgery. He retired from practice about 1775, and died Aug. 17, 1781.

Among his general compositions are: "Observations sur les Becs de Lièvre de Naissance" (*Mém. de l'Acad. Roy. de Chir.*, T. I, 1748); "*Principes de Chirurgie*" (Paris, 1731, and numerous succeeding editions both in Paris and Berlin, as well as several in Strassburg, Venice, Stockholm, and Madrid). He also wrote a number of ophthalmologic articles, the most important of which was "The Reform of Instruments for Cataract Extraction" (*Mém. de l'Acad. Royale de Chirurgie*, T. II).

Among his inventions for the use of general practitioners was an apparatus for the protection of shattered limbs, a device which remained in use for many years. Ophthalmologically, he was still more useful. He it was who invented the first cataract knife and the first cystotome, as well as also the name itself (not a very happy one) of the latter instrument.

Here is what the inventor of the first cystotome and first cataract knife had to say about these instruments in an article offered to the Royal Academy, and entitled "Mémoire pour Servir à Perfectionner la Nouvelle Méthode de Faire l'Operation de la Cataracte" (*Mémoires de l'Académie Royale de Chirurgie*, Tome II, pp. 563-577): "When I saw the cataract operation performed by extraction, I saw, like every master of the art [this was merely the customary modesty of the day] that this method possessed certain advantages over the old one; but I discovered at once that the great number of instruments which M. Daviel employs, rendered the performance very complicated, and that one could shorten and simplify it by the use of one single instrument for the corneal incision and only one other for the opening of the capsule. . . .

"The knife for the cataract incision is a small bistoury, fastened immovably in a handle; the blade is thin, a little curved on the surface, 20 lines long, 2 lines in the greatest breadth. It cuts on one edge only, except at the point, where the back is also sharp for 2 lines. It is held after the fashion of a pen.

"The second instrument, which I call *cystitome*, resembles a pharyngotome, only it is somewhat smaller. The sheath is curved a little on the flat, 1 line wide, 7 lines long. The lancette is very small, and protrudes only 1/4 line, when the spring is released. One needs no spoon with which to lift the cornea, and so has the second hand free.

"After I had shown the instruments to the pupils, and tried them on the cadaver, I performed with them at the Hôtel des Invalides,

June 11, 1753, 6 cataract operations. I enter the knife into the cornea ½ line from the temporal margin thereof, opposite the pupil, carry it through the anterior chamber, thrust it out at an equal distance from the corneal margin, incline the cutting edge a trifle forward, and let it slowly glide: thus I complete to the lower border of the cornea a half-moon-shaped incision, with an oblique incision-surface, and large enough to permit the egress of the lens. When I press gently on the eyeball, the lens comes forward from its bed and falls upon the cheek. Now and then the lens-capsule prevents the emergence of the lens. In such cases one employs the cystitome. This I had to do in two out of the six cases. The operation lasts no longer than a minute."

The entire article in the "*Mémoires*" fills but fourteen pages, yet what an important article it is for the history of ophthalmology! If Daviel invented cataract-extraction, de la Faye at all events rendered the procedure practical.

A more complete understanding of the progress made in cataract surgery by de la Faye can be had by reading in connection with the present article that on **Daviel.**—(T. H. S.)

Fear, Ocular signs of. Fear is one of the primary emotions, and arises from the expectation of harm and the desire to escape it. Stout assumes that it is due to circumstances and experiences which are unfamiliar; Bain that it is due to the foreboding of evil; while Spencer, thinking of race-experience and instinctive fear, attributes it to the memory of past pain. In fear the mind concentrates on one single idea. This results in specific pain and misery, which sometimes lead to temporary paralysis of the active forces. The physical expressions of fear are among the most familiar of experiences. In detail, fear involves a disturbance of both the muscular and the visceral systems. The physical signs of a typical case are mainly these: open mouth due to relaxation of jaw muscles, raised eyebrows, arrest of muscular activity, sometimes crouching "as if instinctively to escape observation" (Darwin), hurried respiration, enfeebled expiration, palpitation of the heart, pallor of skin, perspiration (cold sweat, due to vasomotor and secretory nerve disturbances), erection of skin hairs (goose-skin), tremor of superficial muscles, arrest of salivary secretion, disturbance of other glandular secretions (e. g., breasts), trembling of limbs, lips, etc., huskiness, indistinctness or total failure of voice, dilatation of nostrils. In extreme terror there may be staring and protrusion of eyeballs, extreme dilatation of the pupils, convulsions, the specific scream or screech or howl of terror, followed by relaxation of muscles and total collapse.—(*Standard Encyclopedia.*)

Febbre ricorrente. (It.) Recurrent fever.

Febrile herpes. See Vol. V, p. 3372, of this *Encyclopedia*.

Feces in ophthalmic diseases. The examination of the dejecta in many diseases of the eye is of considerable importance, and especially in those disorders of metabolism that are directly or indirectly responsible for a number of ophthalmic affections—particularly of the uveal tract and optic nerve. This subject is discussed under **General diseases**, as well as under several special headings. An excellent paper on this subject is by S. H. Browning (Importance of Examination of Feces and Urine in Eye Diseases, *Ophth. Rev.*, xxxii, p. 101, 1913).

Fechner, Gustav Theodor (1801-87), one of the founders of psychophysics, was born at Gross-Särchen in Lower Lusatia, Germany. He became a professor of physics at Leipzig in 1834. Five years later, he abandoned these branches for that of philosophy and psychophysics. His most important book on this subject is *Elemente der Psychophysik*. He brought out an enlarged translation of Biot's *Handbook of Experimental Physics*.—(*Standard Encyclopedia.*)

Fechner's (paradoxical) experiment. An experiment introduced by Fechner in the domain of the color-sense for the determination of binocular light-perception. In the case of most observers, when one eye is closed, Fechner found that at first there was a slight clouding of the common visual field, but this was quickly followed by an equal clearing up of the field. If the visual field of one eye is darkened by a gray glass held before the eye, and then the common visual field or a white object in it be regarded, the latter appears darker than when the eye behind the gray glass is entirely closed.—(Foster.)

Fechner's law. The so-called psycho-physical law of Fechner, relating to the light sense, is as follows: The impression made on our senses by light is not proportional to the intensity of the light, but is approximately proportional to its logarithm. The sensation, therefore, changes very much less than the intensity of the light which causes it. Thus a change in intensity from 1 to 1,000 candle-power is a thousand times as great as from 1 to 2 candle-power, but the change of sensation in the first case is only about ten times as great as in the latter.

Mathematically this law can be expressed as follows:

$$L = A \times \log \frac{i}{i_0};$$

where L = physiological effect; A = a proportionality constant; i = intensity of illumination; i_0 = the minimum perceptible

value of illumination, the so-called "threshold value," below which sensation ceases.

From Fechner's law can be drawn the important conclusion that the smallest perceptible (and therefore also the largest permissible) variation in illumination is a constant fraction of such illumination. For the average human eye this fraction is about 1.6 per cent. Therefore, in order to be satisfactory for close work, a commercial illuminant must not flicker or in any other way deviate from the normal by more than this percentage.

Federbarometer. (G.) Aneroid barometer, devised by Bigi in 1847. This is a small, round metallic box, nearly exhausted of air, with a thin, corrugated lid which the weight of the atmosphere tends to press in more or less. A system of levers causes an index, sweeping over a dial, to mark the slightest movements of the thin lid.

Fees of the ophthalmologist. It is quite impossible to treat this subject in a practical fashion since the variation of fees in all countries, but especially in America, prevents a satisfactory account of the ophthalmologists' charges for services. Occasionally some medical society, more or less prominent, issues a table of fees, but not even the members of the society appear to be bound by it in any particular. Even the law courts, in allowing compensation to specialists, vary greatly in their decisions. In the United States, in particular, this matter is generally settled out of court. When a judicial decision is given it is largely determined by circumstances of the locality, reputation of the surgeon, the wealth or otherwise of the patient, etc.

The *Practica Oculistica*, Rome, November, 1912, publishes the fees of the Italian oculist. These, in part, are as follows, a lire being worth in American money about 20 cents: Office consultation, 10-20 lire; succeeding visits, 5-10; visit to the patient's house, 20; succeeding visits, 5-10; consultation fee, 20-50; complete examination without report, 20-50; complete examination with report, 50-100; prescription for spherical lenses, 10; prescription for cylindrical lenses, 20; prescription for combined lenses, 25-30; cataract operation, 500-5000; iris operation, 250-500; removal of foreign bodies from the cornea, 20-50; removal of tumors from the conjunctiva, 50-300; paracentesis, 25-50; orbital operation, 200-2000; squint operation, 200-1000; enucleation, 200-500; exenteration, 100-200; ptosis operation, 200-500; excision of the lachrymal sac, 200-500; lachrymal probing, 10-20; pterygium operation, 50-100; penetrating wounds of the globe, suture and excision of prolapsed tissue, 200-300.

As regards fees for expert testimony it is somewhat different. As Thomas Hall Shastid (*Modern Ophthalmology*, p. 841) states, "In

civil cases, the mileage and *per diem* must be paid, or at least tendered, to render the service of the subpena effective, while, in criminal cases, not even so much as that is necessary. This is true of all witnesses—mere fact witnesses and expert, or opinion, witnesses alike. However, in the case of expert witnesses the question arises whether the same slender payment that is made in the case of a fact witness should be held to be sufficient in the case of him who renders scientific testimony—testimony involving, presumably, the possession of learning and skill. Ought, or ought not, an opinion witness, an expert, to be obliged by law to hold his store of knowledge free for the use of all who take it into their heads to litigate? The ablest authors answer this question in the negative. They say that the expert's learning and skill are his property, and that the law has no more right to compel him to render expert testimony without adequate compensation than it has to compel him to render, without adequate compensation, professional services of any other sort. However, the writers and the courts are not in harmony on this point. The courts indeed hold, with very unusual unanimity, that the expert, medical or lay, may be compelled to testify in his expert capacity without other compensation than that of an ordinary witness. However, in a few States provision has been made by statute for the payment of special fees to experts.

Fehlerausgleichung. (G.) Compensation of errors.

Feigned blindness. See **Blindness, Simulation of.**

Feilenhauer. (G.) File cutter.

Fel. (L.) Bile.

Feld. (G.) A field, area or tract.

Felke process. A quack method of diagnosing disease, originating in Germany. Considerable literature, lay and professional, has grown up about this form of empiricism. See a paper on the subject by Salzer (*Münch. med. Woch.*, lvii, p. 417, 1911), who reviews the German literature with regard to the Felke process, which has been adversely passed on by the German courts.

Fellmongers' disease. Anthrax. So called because it often attacks dealers in fells, i. e., pelts and skins.

Fel metallorum. (L.) An old term for crystallized silver nitrate.

Fenchel. (G.) Fennel.

Fenestra oculi. (L.) An obsolete term for the pupil.

Fenestrated cataract. A partially opaque lens in the midst of which there is a windowlike opening of transparent crystalline substance through which vision is more or less preserved. This condition is not uncommonly found in senile cataract.

Fenêtré. (F.) Fenestrated.

Fennel. *Fœniculum vulgare.* The dried fruit of this and other varieties yields from 2 to 5 per cent. of a camphoraceous, sweet-tasting, volatile oil to which the medicinal qualities of the plant are mainly due.

This plant furnishes a number of ophthalmic mixtures, most of them belonging to the home-treatment variety, and it is difficult to say what therapeutic value, if any, is to be attached to them. A weak tincture of the seeds enters into the composition of Romerhausen's eyewater (q. v.), and fennel water *(aqua fœniculi)* is a frequent addition to European collyria for the relief of simple conjunctivitis and hyperemia of the lids. The latter preparation is used for this purpose abroad as much as rose or camphor water is prescribed in America.

[Fennel was greatly esteemed by ancient Greco-Roman physicians (it is mentioned by Archigenes, Dioscorides, Pliny and Scribonius Largus) as an ingredient of numerous collyria. The root, furthermore, was sometimes employed in the form of a poultice to the forehead for ocular affections. It was thought that fennel was eaten by serpents to assist in the castings of the skin and also to strengthen the eyes.—(T. H. S.)]

Fente. (F.) Cleft; crevice; fissure; slit.

Fente palpébrale. Palpebral fissure.

Fer. (F.) Iron.

Fer-chaud. (F.) Heartburn; pyrosis.

Ferite. (It.) Wounds; injuries.

Ferment. An organic body, capable, in small quantities, of decomposing other organic bodies without yielding any of its own substance to the product of the fermentation. Ferments are generally divided into two classes, the *organized* and the *soluble* ferments.

An essay on the actions of ferments on the eye, especially in their relation to sympathetic ophthalmia, is published by H. Guillery (*Archiv f. Augenheilk.*, 68, p. 242, 1911).

Fermentation saccharimeter. An instrument for measuring the amount of sugar in urine.

Fernobjectiv. (G.) Telephotographic lens.

Fernpunkt. (G.) The punctum remotum, or far point.

Fernpunktsbestimmung. (G.) Determination of the punctum remotum.

Fernrohr. (G.) Telescope.

Fernsehen. (G.) Hypermetropia.

Fernsichtigkeit. (G.) Far-sightedness or hypermetropia.

Ferrall-Bonnet operation. Bonnet operation. See **Enucleation of the eye.**

Ferré. (F.) Containing iron or one of its compounds.

Ferree test. The determination of eye-fatigue. The method of conducting the Ferree test is as follows: The observer under test is required to gaze steadily for a short period of time (usually about three minutes) at a card upon which are printed certain letters, or characters; these letters being of such a size that they are just barely distinguishable at the distance selected for the test. During the period of time that the observer gazes at the letters he is required to record on a chronograph or stop watch, by the pressing of a button, the intervals when the test object appears blurred. The percentage of the time which the observer sees the letters blurred is taken as an indication or measure of the amount of fatigue of the eye at the time the test is made. Before beginning such a test it is of course important to determine the proper distance at which to place the test card from the eye of the particular observer under test because, if too great a distance is taken, the test letters may appear blurred during the entire test intervals, in cases where there has been considerable eye fatigue; and, on the other hand, if too short a distance is taken the observer may see the test letter clear for the entire time during tests when the eyes are but little fatigued.

The experiments of T. R. Cravath (*Trans. Illum. Engin. Soc.*, Cleveland, Sept. 21, 1914) indicate that the Ferree method is reasonably sensitive both to eye fatigue caused by illumination and to eye fatigue due to other conditions such as abnormal eye-strain, headaches, unusually difficult eye work and irritation due to dust in the eyes. If it is used as a test of illumination conditions care should be taken to eliminate as far as possible the other variables and to throw out tests where these variables influence the result. See, also, **Fatigue** and **Eye-strain.**

Ferrein, Antoine. Born at Frespech, Argenois, Oct. 25, 1692, he studied at first theology, mathematics and law with the Jesuits at Agen. His attention having been turned toward medicine by Borrelli's "*De Mortu Animalium*," he betook himself to Montpellier, where he received the Bachelor's degree in 1716, and, a little later, the Doctor's degree. He served for a time as army physician in the French campaign in Italy, then, in 1741 (after many vicissitudes) he became anatomist at the Academy of Sciences. Next year he was made professor of medicine and surgery at the Royal College in Paris.

Ferrein composed a handbook, or treatise, on practical surgery and medicine, and a number of articles on the anatomy and therapy of the tear-apparatus.

Ferrein claimed that he was the first to propose and practise lacera-

tion of the posterior inferior quadrant of the lens-capsule as a preliminary to reclination of the lens. The opening in the capsule Ferrein called "the button-hole." History has awarded the palm for priority in this procedure to Petit, who, at all events, was the first to give information concerning the matter to the public.—(T. H. S.)

Ferrein, Canal of. A triangular channel once supposed by Ferrein to exist between the free edges of the eyelids when they are closed, and to serve for conducting the tears toward the puncta lachrymalia during sleep.

Ferrer, Henry. A well-known ophthalmologist of California. Born Feb. 17, 1850, at Santiago de Cuba, he obtained his general education at Bordeaux, France, then studied medicine at Heidelberg, receiving his degree in 1872. After a considerable graduate period, at London, Paris, and Vienna, he became assistant to Professor Soelberg Wells, at London.

In 1875 he settled in San Francisco, Cal., where he soon had a large practice.

Among his most important writings are: "Abscess of the Middle Ear and Mastoid Cells" (1877); "Report of a Case of Disease of the Mastoid Process, with Remarks" (Knapp's *Archives of Otology,* Vol. XVII and XVIII).

Dr. Ferrer was a small, but finely built man, a very dark brunette, with soft and delicate hands, which, in conjunction with a naturally surgical mind, made him an operator of remarkable dexterity. He was lovable in character, and had many friends.

He died at Santa Barbara, Cal., Oct. 22, 1890, at the early age of 40.—(T. H. S.)

Ferripyrin. Ferropyrin. This agent is a mixture of chloride of iron and antipyrin. It is an orange-red powder, soluble in water, containing 12 per cent. of iron and 64 per cent. of antipyrin. Locally it acts as a styptic; internally, it is given in anemia and chlorosis, three or four times daily in 0.05 grm. doses.

Ferro-sajodin. This iodine-iron compound is occasionally recommended in ophthalmic affections due to general causes. A paper on the subject is by P. Cohn (*La Clinique*, Vol. IX, May 13, p. 531, 1911), to which the reader is referred.

Ferrotype. A photographic positive on a sheet-iron support.

Ferruginous collyrium. A collyrium introduced by Niemann, made by mixing from 2 to 5 parts of iron sulphate and 60 of white sugar.

Feste Augenhaut. (G.) The cornea, in the sense of the older anatomists.

Fester Staar. (G.) Fixed cataract.

Fetal eye. See **Development of the human eye.**

Fetid cataract. See page 1493, Vol. II of this *Encyclopedia.*

Fett. (G.) Fat.

Fettablagerung. (G.) A fatty deposit.

Fettbläschen. (G.) Fat cell.

Fettdrüsen. (G.) Sebaceous glands.

Fettentartung. (G.) Fatty degeneration.

Fettes Augenfell. (G.) Pterygium.

Fettgewebe. (G.) Adipose tissue.

Fettgewebsläppchen. (G.) Fat lobules.

Fettherd. (G.) A collection of fat.

Fettkörnchen. (G.) Granules of fatty matter found in the various tissues and fluids of the body.

Feu. (F.) Fire, combustion. A burning sensation. The application of the actual cautery. A popular name for certain skin diseases characterized by redness, itching, etc., such as acne and erysipelas.

Feuchtigkeit. (G.) Humidity.

Feu de Saint-Antoine. (F.) Erysipelas.

Feuer. (G.) Fire.

Feuille. (F.) Leaf; lamina; layer.

Feuille nervoso-cutané. (F.) The epiblast (Remak).

Feuillet. (F.) Layer; lamina.

Feuilleté. (F.) Laminated.

Feuillet moto-germinatif. (F.) The mesoblast (Remak).

Feuillet moyen. (F.) Mesoderm.

Feuillet proligère externe. (F.) The primordial ectoderm.

Feuillet proligère interne. (F.) The primordial entoderm.

Feuillet sensoriel. (F.) The epiblast (Huguier).

Feuillet vasculaire. (F.) The mesoderm.

Feu nu. (F.) The application of the actual cautery.

Feu sacré. (F.) Erysipelas.

Feu Saint-Antoine. (F.) Gangrenous erysipelas.

Feu Saint-Marcel. (F.) Erysipelas.

Fève. (F.) Bean.

Fever. This symptom (rise of bodily temperature) of many different pathological conditions is thought by some to be now and then productive, *per se*, of eye symptoms. For example, see a paper by E. von Czyhlarz (*Berlin. Klin. Wochenschr.*, Jan. 20, p. 112, 1913), where the nystagmus as a result of fever is discussed.

Hirschberg also discusses fever in ocular inflammations in the *Centralb. f. pkt. Augenheilk.*, 35, p. 193, 1911. See, also, **General diseases**; as well as **Exanthemata.**

Fibers, Mueller's. Fibers of connective tisue which run perpendicularly through the retina.

Fibræ arcuatæ. A term applied by the older writers to the oblique fibres of the cornea, showing most plainly just behind Bowman's membrane.

Fibralbumine. (F.) Globulin.

Fibre-axe. (F.) Axis-cylinder.

Fibre-cellule. (F.) Unstriped muscular fibre.

Fibre-cross. Cross-wire. Cross-hair. A fine strand, as of spider's thread, or a pair of parallel or transverse wires or strands, mounted in the focal plane of an optical instrument.

Fibres à moelle. (F.) Medullated nerve fibers. The naked axis-cylinders seen in the gray substance of the central nervous system.

Fibres à myéline. (F.) The naked axis-cylinders found in the gray substance of the central nervous system.

Fibres, Association. Almost every cerebral center is connected with every other by fibres of communication, which bear the foregoing name.

Fibres, Bechterew's. See p. 918, Vol. II of this *Encyclopedia.*

Fibres, Bernheimer's. See Vol. II, p. 941 of this *Encyclopedia.*

Fibres, Bogrow's. See Vol. II, p. 1241 of this *Encyclopedia.*

Fibres, Centrifugal. See **Centripetal fibres of the optic nerve.**

Fibres, Centripetal. See page 1966, Vol. III of this *Encyclopedia.*

Fibres, Cilio-equatorial. One of the several classes of fibres constituting the zonula of Zinn.

Fibres cortico-optiques. (F.) The nerve-fibres which connect the optic thalamus with the cortex cerebri.

Fibres, Darkschewitz's. See page 3749, Vol. V, of this *Encyclopedia.*

Fibres, Edinger's. See Vol. VI, p. 4156 of this *Encyclopedia.*

Fibres, Gudden's. These connect the basal optic centres with the tractus peduncularis transversus.

Fibres, Monakow's. The optic fibres that run from the colliculus anterior to the eyeball.

Fibres, Perlia's. These connect the medulla oblongata with the optic centres at the base of the brain.

Fibres, Projection. Fibres of the corona radiata, constituting (in opposition to "association" fibres) the medullary substance of the occipital lobe.

Fibres suturales. A synonym of arcuate fibres—of the anterior limiting membrane of the cornea—for which see **Anatomy of the eye,** as well as **Histclogy of the eye.**

Fibreux. (F.) Fibrous.

Fibrinous cataract. FIBROID CATARACT. (*Obs.*) This form of opacity of the ocular media, constituting one form of false cataract, has nothing to do with the lens or its capsules. It is in most instances a deposit on the surface of the anterior capsule without implication of that membrane, and is the result of an iritis, a "descemetitis," or it may even be a keratitis. See **Cataract, Spurious.**

Fibro. This prefix in the nomenclature of tumors indicates the presence of a certain percentage of fibrous tissue in the mass. Sometimes this connective tissue or fibroid material predominates; in other instances it does not. Thus we have *fibro-angioma, fibro-sarcoma, fibro-chondroma, fibro-glioma, fibro-lipoma,* etc. See **Tumors of the eye.**

Fibrolysin. This is a trade name for a sterilized solution of thiosinamin and sodium salicylate. It contains 15 per cent. of the double salt. In addition to the matter to be found under **Thiosinamin,** Grossman (*The Lancet,* Jan. 16, 1909) gives the following account of this agent.

It was introduced in 1905 by Mendel of Essen, although as far back as 1892 von Hebra published the favorable results he had obtained in the healing of lupus and of cicatricial tissue by means of thiosinamin, a preparation made from the oil of mustard, smelling strongly of garlic, and having the chemical composition of allyl-sulpho-urea. These good results were verified by others, but the remedy did not become popular, for one good reason—its almost complete insolubility in water.

Fibrolysin represents a combination of one molecule of thiosinamin with half a molecule of salicylate of sodium. Its principal advantage over thiosinamin is its easy solubility in water and the absence of any irritant effect when injected subcutaneously. The drug itself is a white, crystalline substance with a bitter taste. It decomposes easily when exposed to air and light and is therefore put up in closed tubes of brown glass in doses of 2.3 cubic centimetres of a 15 per cent. aqueous solution, equivalent to two decigrams (three grains) of thiosinamin.

The effect of fibrolysin on cicatricial tissue is very remarkable; turgescence takes place, the individual fibers lose their sharpness of outline, the nuclei are pushed asunder, and the tissue appears more succulent and swollen and altogether enlarged. The whole scar becomes more relaxed and permits of movements altogether impossible before injection. This effect Grossman believes to be due to a serous infiltration, or flooding, which softens the old, inflammatory and now hardened tissues similar to the hyperemia of the Bier method, and renders them more amenable to absorption by the lymph stream. The result, transient at first, is greatly increased by repeated injections.

It is noteworthy that fibrolysin has this effect only on pathologic connective tissue.

The mode of application is by injection, either intravenous, intramuscular, or subcutaneous. Under the influence of the drug dilation of strictures and stenoses of the esophagus, pylorus and lachrymal passages by bougies becomes possible and remains permanent.

Grossman reports several cases, one of cicatricial shortening of the eyelids, which would usually have been subjected to a not altogether successful plastic operation in which after ten injections, first of 1 cc., later of 2, 3 cc., the eyelids opened and closed well; another of retrobulbar neuritis after influenza in which six injections were "thoroughly satisfactory"; clearing of corneal opacities not so satisfactory, but all improved a little; "great success" in 2 cases of posterior synechiæ; three injections in lachrymal stenosis rendered further probing unnecessary.

He mentions some disagreeable symptoms which have been described as sometimes accompanying or following the application of fibrolysin —viz., a burning sensation round the point of injection lasting half a minute to a couple of hours, discoloration of a yellowish, later bluish, tint, formation of a hard nodule of the size of a cherry which may take weeks or even months to disappear. There are also general symptoms reported; headache, lassitude, and heaviness lasting from a few hours to a day or more. Urbantschitsch mentions a case where, regularly 12 hours after each injection, menstruation occurred; this resembled normal menstruation and lasted from two to three days. For this reason the further administration of the drug had to be abandoned. Another case is mentioned in which epistaxis occurred.

As a note of warning Grossman quotes the experience which Glas relates in 1903 in a case of nasopharyngeal syphilis. After the fourth injection of thiosinamin edema and swelling of the epiglottis set in and developed to such a degree that tracheotomy had to be resorted to. It is, consequently, best to begin with a small dose, 1.0 cc., and avoid the time of menstruation.

Wolffberg (*Wochenschr. f. Ther. und Hyg. des Auges,* Aug. 21, 1913) also recommends it as a local application in obstruction of the lachrymal canals due to cicatricial tissue.

Fibroma. A generic term for fibrous tumors developed from proliferous connective-tissue cells. Hence they are mostly found in the nerves, skin, fasciæ, periosteum, and glandular organs. Though multiple they do not give rise to metastatic tumors.

The best known ocular fibromata are those found in the lids. See **Eyelids, Fibroma of the.**

D. Velhagen (*Cent. f. Prakt. Aug.*, Feb., 1912, p. 33) has described a rare form of *fibroma molluscum* in the upper lid. A pear-shaped tumor, inserted with a thin pedicle on the nasal portion of the border of the left upper lid of a woman, aged 60, hung free on the face as far as the nasolabial fold. It was 30 mm. long, its greatest width being 25 mm. It was of soft consistency and covered with smooth skin. Otherwise the lid was perfectly normal and the palpebral fissure as wide as the other. There was a wart of the upper lid, 10 small angiomas of 1.5 mm. circumference and a few specimens of *cutis pendula* on the skin of the neck. The patient first noticed the tumor 30 years before. It grew slowly until five years ago. It was easily removed and on microscopical examination found to be a neurofibroma.

Fibromata of the conjunctiva, cornea, iris and orbital cavity are also known.

For example, a *mucous fibroma* of the bulbar conjunctiva is reported by Trousseau (*Annales d'Oculistique*, March, 1906). A man, 57 years of age, stated that the trouble in his eye had commenced fifteen years before he applied for treatment. At that time he noticed a little, whitish tumor, scarcely as large as a millet seed, on the nasal side of the bulbar conjunctiva of his left eye. It occurred without traumatism, irritation or preceding disease of the eye. His general health was excellent, and he gave himself little concern about the growth, which did not inconvenience him. It developed slowly but steadily and gradually assumed a reddish tint. At the time of the examination it extended from the caruncle to the corneal limbus, but was not adherent to the latter. The size of the tumor was that of a large olive. It was of a reddish color, and the conjunctiva over it was traversed by large vessels. It was enucleated without difficulty, as it had no firm adhesions. Examination showed it to be a fibrous tumor of the submucous connective tissue. Trousseau believed that no similar tumor in this location had been reported before.

Cosmettatos (*Annales d'Oculist.*, 145, p. 282, 1912) describes a congenital fibroma of the orbit. The lower border of the left, normal, eye corresponded in level to the upper part of the globe of the right, affected, eye. The lid of the right eye covered the greater part of the eye, and was raised with difficulty. The antero-posterior axis was directed downward and outward. The vertical diameter of the right orbit at its margin was 2 mm. greater than that of the left. The increase in size of the right orbital cavity was at the expense of the malar bone, and of the superior maxilla. The patient, who was twenty-two years old, stated that he had been born with the right eye in the relative position which it still occupied. This statement was con-

firmed by a brother. A fibroma was removed through an incision in the upper lid. It had been attached to the external orbital wall, and had pressed upon the upper surface of the globe. After the operation the eye took a somewhat higher position, but still not so high as that of the left eye. The author regards the tumor as having developed during fetal life. See, also, **Fibromatosis.**

Fibroma, Sclerocorneal. A name for vernal conjunctivitis.

Fibromatosis. This term is generally applied in ophthalmology to intradural tumors of the optic nerve—*fibromatosis nervi optici.* The phrase was applied by Byers in 1901 to true intradural and primary tumors of the nerve, he having been able to collect accounts of 102 cases in the literature.

Age is a factor in this disease. Of 85 cases collected by Byers in which the age was recorded, 67 occurred at fifteen years or younger; 32 cases occurred between the first and fifth years. The disease is found more frequently in females than in males, and more often on the left side. Trauma and febrile disturbance or infectious disease are apparent etiologic factors.

The most striking symptom is the gradual development of painless exophthalmos, the direction of the proptosis being in the majority of cases directly forward, or forward, downward and outward, although it may be forward and upward, outward, or inward. Exceptionally the exophthalmos has developed rapidly. The patient may complain of pain throughout the distribution of the fifth nerve. The proptosis is attributed chiefly to the direct influence of the tumor, although, in some instances, it is influenced by the state of the orbital blood-vessels, or by stasis in Tenon's space and in the supravaginal lymph-space of the nerve.

A second symptom of importance is the early and great loss of vision. In 69 per cent. of the cases tabulated by Byers vision was absolutely lost in the affected eye at the time of first examination. Variations in visual acuity have been recorded in individual cases.

The ophthalmoscopic changes are various. Of 82 cases in which mention is made of the condition of the fundus, 3 showed simple atrophy of the optic nerve, 34 presented optic neuritis, and 36 gave evidence of post-neuritic atrophy. In 3 cases the fundus was normal. Among the ophthalmoscopic appearances rarely found in primary tumors of the nerve are dilation of the retinal veins, partial detachment of the retina, and hemorrhages. The majority of patients present no lesion of the orbital muscles, although strabismus sometimes is noted, and, indeed, may precede the exophthalmos. In some cases palpation will enable the surgeon to determine the presence of an

intra-orbital growth which is not adherent to the orbital walls. The general appearance of the patient does not usually differ from the normal; but cerebral symptoms—such as convulsions and epileptic seizures—have been noted in rare instances. Vertigo and tinnitus aurium are rarely present. As regards the eyeball, tension is usually normal, but may be minus or plus. A characteristic symptom is antero-posterior flattening of the globe from pressure of the tumor posteriorly, causing the eye to become hypermetropic. Lagophthalmos and keratitis have also been found present.

The dural covering of the nerve forms a capsule, one-half to one millimetre in thickness, which envelops the tumor. The growth may vary in size from a slight enlargement of the optic nerve to a mass the dimensions of a goose egg. Usually a piece of normal nerve separates the tumor from the eyeball. In the opposite direction, however, the growth may extend up to or through the optic foramen, and involve the brain. The microscopic diagnosis of the reported cases shows a large number of different forms, the majority being set down as myxosarcomata, myxomata, myxofibromata, or sarcomata. Since tumors of the optic nerve show, in one and the same specimen, several phases of developing connective tissue, Byers considers that they should all be classed as fibromata. When cerebral symptoms occur, and death ensues after removal of a primary tumor of the optic nerve, the result is to be attributed not to recurrence, but to the continued growth of the intracranial portion of the neoplasm, which could not be removed by operation.

The symptoms enumerated above will enable the surgeon to assert the presence of a growth connected with the optic nerve, but it is doubtful if intradural growths can always be differentiated from extradural ones. The prognosis is serious. The eye in many instances must be sacrificed, and in some cases there is a continued development of the intracranial portion of the tumor, which could not be removed at the time of operation. Where the tumor is located chiefly in the anterior portion of the optic nerve, total removal is feasible.

Since the condition rarely shows a tendency toward malignancy, and because in most cases the neoplasm does not encroach on the globe, modern ophthalmologists have sought to extirpate the growth while preserving the eyeball. Scarpa, in 1816, Critchett, in 1852, Knapp, in 1874, were the first to follow this method. Knapp, in operating on an extradural tumor, made his opening through the conjunctiva and Tenon's capsule between the superior and internal recti, separated the optic nerve from the globe, then cut the nerve at the optic foramen, and pried the tumor out with scissors. Gruen-

ing, of New York, was the first to remove a primary intradural tumor of the nerve with preservation of the globe. Krönlein (see **Orbit, Diseases of the**) has devised an operation which is suitable for these cases.—(J. M. B.)

In an enucleated eye which had a clinical history of keratitis and glaucoma, Goldberg (*Ophthal. Record*, p. 100, 1908) found upon microscopic examination a fibromatosis involving the cornea and uveal tract. The cornea was split into two equal parts, one superficial, which had changed to opaque dense cartilaginous material, the other deep, unaffected and transparent. The epithelium had invaded the diseased portion showing, perhaps, efforts at repair. Such new-formed epithelium was observed also by Gilbert upon the surface of a *pannus degenerativus*, after it had undergone a sclerotic change.

Fibrosarcoma. Combinations—primary or secondary—of fibrous tissue with various neoplasms are not uncommon in the ocular structures. They will be discussed under **Tumors of the eye**, as well as under the structures they mostly affect.

Fibröser Staar. (G.) Fibroid cataract.

Fibrosis. Thickening of a part of an organ or vessel due to the formation of fibrous tissue.

Fibrous coat. A synonym of the cornea-sclera.

Fibrous cordage. A term applied by Ranvier to corneal filaments found in the Ray and other fishes. Bowman has described similar structures in man.

Fibrous tunic. The sclera and cornea together.

Fick, Bacillus of. See Vol. II, p. 739 of this *Encyclopedia*.

Fieber. (G.) Fever.

Fiel. (F.) Gall; bile.

Field glass. A small, portable terrestrial telescope, either monocular or binocular. See **Opera glass.**

Fielding, George Hunsley. A popular English anatomist, who paid considerable attention to ophthalmology. Born at Hull, England, the son of a physician, Oct. 26, 1801, he became in 1824 a Member of the Royal College of Surgeons of England, and practised for a number of years in his native town. He then proceeded to Erlangen, Germany, where he received the degree of Doctor in Medicine in 1836. Returning to England, he settled at Tunbridge, Kent, where he practised for many years. In 1843 he was made a Fellow of the Royal Society. He died at Dry Hill, near Tunbridge, May 24, 1871.

Fielding wrote but two ophthalmologic articles, as follows: 1. On a New Membrane in the Eye, etc. (London, 1832.) 2. On the Influence of Color on the Effect of Light, Heat and Odors.—(T. H. S.)

Fielding, Sir John. A celebrated lawyer, jurist, and philanthropist, son of General Edmund Fielding and half-brother of the author of "Tom Jones." He was totally blind from childhood, and yet, so great were his varied abilities, that he received the honor of knighthood, wrote numerous excellent books on various subjects of importance, and, finally, became the first chief magistrate of the United Kingdom.

The place and the date of his birth are alike unknown. After the onset of blindness he received from his parents an excellent general and legal education. On the death of his half-brother, Henry, the celebrated novelist, "blind Sir John" was appointed in his stead as magistrate at the Bow Street Police Court. So acute was Sir John's legal understanding that he was sometimes called "Blind Fielding, the Thief-Catcher," and, again, "the English Solomon." He never forgot, it is said, a former culprit's voice, character or history. It is, in fact, asserted that he knew over three thousand thieves by their voices. He was probably the first to abolish absolutely the giving and taking of bribes.

In 1761 he was made chief magistrate, and, soon after, received the order of knighthood.

In 1785 he established, it is said, the first orphan asylum in England. This was known as "The Female Orphan Asylum," and was situated on Westminster Road, Lambeth. He was also one of the benefactors of the Marine Society and of the Magdalen Hospital.

He was a man of excellent wit and fond of telling stories. Those which he most enjoyed narrating were, as a rule, about Irishmen. There is one that he told repeatedly: When Sir John was a magistrate at Bow Street, an Irishman, brought before him on some minor charge, attempted to pose as an Englishman. In fact, he declared that he "came from" Chester. "What!" exclaimed Sir John, noting the rich Irish brogue, "were you ever in Chester?" "To be sure I was," replied the culprit; "wasn't I born there?" "How dare you," cried the irascible magistrate, "with that brogue pretend you were born in Chester?" "I didn't say I was born there," answered the Irishman, "I only asked your honor whether I was or not."

A list of Sir John Fielding's more important writings is as follows:

1. A Charge to the Grand Jury of Westminster. (1735. Published at the request of a large number of people.)

2. Extracts from Such of the Penal Laws as Particularly Relate to the Peace and Good Order of the Metropolis. (1761.)

3. The Universal Mentor, containing Essays on the Most Important Subjects in Life; Composed of Observations, Sentiments, and Examples of Virtue. (1762.)

4. Another Charge to the Grand Jury of Westminster. (1766.)

5. A Plan for Preventing Robberies within Twenty Miles of London, with Advice to Pawnbrokers. (1768.)

6. An Account of the Origin and Effects of a Police Set on Foot by his Grace the Duke of Newcastle, in the year 1753, upon a Plan Presented to his Grace by the late Henry Fielding, Esq. (1768.)

7. A Plan for Preserving those Deserted Girls in this Town, who become Prostitutes from Necessity. (1768.)

8. A Brief Description of the Cities of London and Westminster. (1777.)

9. "Sir John Fielding's Jests." Published after Fielding's death, and probably spurious—at least in greater part.

Sir John died at Brompton place, Sept. 4, 1780, one of the best loved men in England.—(T. H. S.)

Field-lens. The lens mounted opposite to the eye-lens in an eye-piece and which is exposed to the image projected by the objective within the tube of a microscope or telescope, its purpose being to enlarge the field of view.—(C. F. P.)

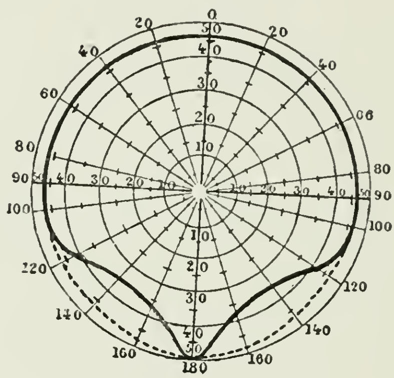
Field of a lens. The surface approximately passing through the foci of all points within the efficient range of a lens. This surface is in most instances somewhat curved, but it is preferable that it should be as flat as possible.

Field of fixation. The field of fixation is determined in the same manner as is the visual field, except that the patient is directed to follow with the affected eye the test-object (which may consist of a small printed letter) as it is carried outward along the arc of the perimeter and make known when he can no longer decipher it. This method is of especial value where the defect is slight or where more than one muscle is affected. Example: In paralysis of the inferior oblique the field of fixation would show contraction above and to the outside. Stevens has designed an instrument for measuring the rotation of the eyes in all directions.—(J. M. B.)

The editor has also made use of the perimeter for determining the limits of the monocular field of fixation. See Vol. VI, p. 4696 of this *Encyclopedia*.

The binocular field of fixation is of extreme importance in cases of squint. It is defined by Landolt (Norris and Oliver's *System*, Vol. IV, p. 53) to be the extent of the space over which "the lines of sight of the two eyes can meet in the same point of fixation. This experiment should be made at such a distance that the convergence may be disregarded. We use for this the mural division which we have described in the discussion of subjective stabometry. We have marked for this

purpose upon the wall the tangents of the multiples of 5° in nine meridians, separated by 20° from each other, also the meridians, inclined at 45°. (See the figure.) The person to be examined is placed before this division in such a way that his eyes correspond to the centre of the imaginary hemisphere whose projection is inscribed on the wall and floor. The head is fixed by means of a dental strap supported by a solid pedestal. Then one moves, along the principal meridians of the chart, a lighted candle, which the patient follows with his eyes until he commences to see it double. The point at which this diplopia appears constitutes the limit of the field of binocular fixation in each given direction. This is recorded on a scheme like that used



Binocular Field of Fixation.

for the record of the monocular field. The perception of the diplopia is favored by a colored glass, which is best held by the patient himself before one of his eyes. The full line in the figure corresponds to the normal field of *binocular fixation* of the author. The pointed curves at the left and right of the lower part of the figure are nothing else than the infero-external limits of the *monocular* fields of fixation. The nose prevents this space from being dominated simultaneously by both eyes."

Field of regard. A name for the visual field, or field of vision.

Field of view. In general, the area at any distance of view that is encompassed by the naked eye, or through the aid of an instrument, such as the telescope or microscope.

This term is, however, generally applied to the area visible through the microscope when it is in focus. When properly lighted and there is no object under the microscope, the field appears as a circle of light. When examining an object it appears in a part or the whole of the

light circle, and by moving the object, if of sufficient size, different parts are brought into the field of view. The greater the magnification of the entire microscope, whether the magnification is produced mainly by the objective, the ocular, or the lengthening of the tube of the microscope, or by a combination of these, the smaller is the field. The exact size of the field of view may be determined directly by the use of a stage micrometer.

Field of vision. This most important and extensive subject will be found fully treated under **Perimetry**. The practical side of it has been considered to some extent on page 4765 *(et seq.)*, Vol. VI, of this *Encyclopedia.*

Field-stop. In *optics*, the annular diaphragm which limits the field of view in an optical instrument; it is the material stop that subtends the smallest visual angle at the center of the entrance-pupil (q. v.).

Fieno. (It.) Hay. *Febbre del fieno*, hay fever.

Fièvre. (F.) Fever.

Fifth nerve. Trifacial nerve. Trigeminal nerve. Trigeminus. The branch of this great nerve of sensation with which the ophthalmologist is especially interested is the ophthalmic nerve. It is one of three primary branches and enters the orbit via the sphenoidal fissure, after dividing into the frontal, lachrymal and nasal nerves. The frontal nerve passes between the periorbita and the levator muscle. Immediately behind the margin of the orbit it divides into supratrochlear and supra-orbital branches. The former escapes from the orbit internal to the trochlea and supplies the periosteum, the skin at the root of the nose, and inner part of the upper eyelid. The latter emerges via the supra-orbital foramen and supplies the upper eyelid, periosteum of the forehead, and scalp. The lachrymal nerve sends branches to the lachrymal gland, conjunctiva of the external canthus, and upper eyelid, and gives off an inferior branch, which joins branches of the superior maxillary nerve. Branches from the resulting arc supply the lachrymal gland. Stimulation of either stem of this loop causes lachrymation. Division results in the pouring out of a paralytic secretion. The nasal nerve enters the orbit between the heads of the external rectus, passes obliquely across the orbit, enters the anterior ethmoidal foramen, passes between two fronto-ethmoidal cells, enters the nasal cavity, crosses the ethmoidal plate, enters a slit by the side of the crista galli, grooves the inner surface of the nasal bone, and divides into three branches. These are distributed to the nasal mucous lining and the skin as far as the tip of the nose. Before entering the ethmoidal foramen the nerve gives off branches to the ciliary ganglion,

and the long ciliary nerves which pierce the sclera and end in the eyeball.—(J. M. B.)

Fifth-nerve paralysis. Neuroparalytic keratitis. Paralysis of the ophthalmic division of the fifth nerve may be due to any one of many causes: tumors in the pituitary region or at the base of the brain; syphilitic, traumatic, or epidemic meningitis; caries of the temporal bone; fracture of the skull; primary neuritis, a rare cause; disease of the nuclei of the trigeminal nerve; or operation for removal of the Gasserian ganglion for the cure of neuralgia. Whether the lesion is located in the nerve-trunk or in its nuclei of origin in the brain, the result is the same. In paralysis of the fifth nerve winking and lachrymation do not occur; hence the cornea becomes dry and minute foreign bodies settle upon it. Infection takes place and destruction of tissue follows. Since the time of Magendie it has been customary to attribute neuroparalytic keratitis to the loss of the influence of trophic nerve-fibres supposed to be located in the trigeminus, but in the light of modern pathology it is no longer necessary to adopt this hypothesis. Snellen's explanation, that the insensibility of the eye occurring in paralysis of the fifth nerve enables ordinary causes to act unmolested on the cornea, is now generally accepted.

The chief symptom is anesthesia. In paralysis of the entire fifth nerve or of its ophthalmic branch, both cornea and conjunctiva become anesthetic. After optico-ciliary neurectomy the cornea alone is anesthetic, winking and lachrymation remaining and no harm resulting to the cornea. If, however, the branch of the seventh nerve supplying the orbicularis muscle is also paralyzed, the cornea is likely to slough. Neuralgic pain, through the region supplied by the affected ophthalmic branch of the fifth nerve, may precede the anesthesia.

Following paralysis of the fifth nerve the cornea becomes cloudy, the epithelium of its centre is loosened and removed, and this process extends until only a narrow peripheral rim remains. The central ulcer is at first gray; then it becomes yellowish, hypopyon forms, the ulcer perforates, and the iris is engaged in the cicatrix. Healing is followed by a flat scar. Not every case runs a course so severe as this, since the process may not lead to perforation. In neuroparalytic keratitis ciliary injection is present, but lachrymation is absent.

The corneal changes following excision of the Gasserian ganglion can be prevented by stitching the lids together and at the first dressing applying a Buller shield. If these precautions are not observed, the cornea may necrose and the eye be lost. In necrosis and suppuration of neuroparalytic keratitis, pain, lachrymation, and blepharospasm are absent. Ocular tension is usually reduced.

Neuroparalytic keratitis is always a serious disease. If treated early and properly the process can usually be checked and useful vision can be saved. In such cases, after restoration of tissue has occurred, an iridectomy may improve vision.

The preventive treatment has been mentioned above. The curative treatment consists in the application of a bandage, the use of atropin or eserin, and the frequent cleansing of the eye with an antiseptic solution. Electricity may be tried. Nieden advises the hypodermic injection of strychnin in the temple.—(J. M. B.) See, also, **Keratitis, Neuroparalytic.**

Fig. *Ficus carica.* The common fig was recommended as an ophthalmic remedy by Dioscorides and Pliny: the pulp, cooked together with pomegranates, for pterygium, and the juice for ulcers of the lids.—(T. H. S.)

The juice of the fruit of *Ficus tsjela* found in the East Indies, is still employed in ophthalmia.

Fil. (F.) Thread, for sutures; a thread-like structure.

Filaccia. (It.) Charpie; lint.

Filamentary keratitis. See **Keratitis, Filamentary.**

Filamentous cataract. An old term for a cataract in which the lens appears to be full of fine filaments.

Filaments of Ammon. A name for the *lamina basalis* of the choroid. See **Histology of the eye**; also Vol. I, p. 319 of this *Encyclopedia.*

Filaria. A genus of nematodes or thread worms. It is an endoparasite which in hot climates (Africa) often attacks man. It has been found in practically all the eye structures.

The *filaria sanguinis hominis*, the larva of the worm, *filaria bancrofti,* is found in the blood during the night in chyluria, and in the lymph-vessels of the lower limbs and scrotum. It causes dilatation of the lymphatics, hematuria, chyluria, abscesses, lymph-scrotum and elephantiasis. The filaria is conveyed to man through the bite of mosquitoes of the genus *culex*.

Filaria medinensis, the guinea-worm, is an animal parasite the female of which burrows under the skin and then deposits its embryos, which finally cause abscess-formation.

Filaria loa is an African species inhabiting the connective tissue of the body, which it traverses freely. It is seen especially around the eye, where it causes itching and, occasionally, edematous swellings.

Filariæ affecting the human eyes are rarely encountered in America. Vail (*Amer. Jour. of Ophthal.*, December, 1905) reports the second case in which the filaria loa was extracted within the confines of the United States. The patient had become affected while residing in

Africa in 1899; a number of worms were extracted from beneath the skin of the eyelids and other parts of the body during the stay of the patient in Africa. In August, 1901, the writer's examination failed to reveal the existence of any parasite; but in June, 1903, the patient returned and stated that he felt these "eye worms" at times in the eyelids, again in the eyeball and frequently about the ankles, ribs and wrists. In September, 1903, the writer saw "a distinct, independent movement, like what would be made by a small worm an inch long, crawling about under the skin of the upper eyelid. The movements were slow and somewhat clonic. During one of these contractions he grasped the most prominent loop of the worm with a pair of fixation forceps, and then by means of scissors and forceps succeeded in extracting the worm without its being severed or wounded." Two years and eight months since the patient left Africa, these worms were as active as ever, four being felt at various times, limiting their peregrinations to the extremities and especially the tissues about the eyes, particularly on chilly days out of season and cold days following a warm spell, and without interference with the general health.

Rochat (*Practical Medicine Series*, p. 34, 1907) was consulted by a man whom he had previously treated for hordeola and whose eyes were normal. He now complained that his eyes itched and watered. Before the looking glass he had noticed in the white of the eye a "small nerve which moved." On looking strongly downward and after lifting of the upper eyelid, near the upper fornix, a transparent thread was seen, with slow, tortuous movements. It was removed with a pair of forceps through an opening in the conjunctiva and proved to be a filaria loa. The patient had returned from the Congo three years before without noticing any abnormal symptom; his blood was free of embryos, the urine normal (he had hematuria in the Congo); no other specimens have since shown themselves.

Terrien and Prelat (*Arch. d'Ophtal.*, May, 1914) have added another to the comparatively small number of cases of *filaria loa* in the eye, already published. Their patient was a man, æt. 33 years, who came under observation in March, 1914, asking to have the parasite removed. He had become aware of its presence in his eye the same morning when making his toilet. At that time the filaria was near the inner canthus, but when he came to the hospital it was plainly visible beneath the conjunctiva near the outer canthus. It showed as a very wavy, slightly-raised body comparable to a fragment of vermicelli, moving fairly rapidly inwards and outwards on the surface of the sclera. No symptoms were noticed beyond an unusual sensation due to the movement of the parasite. The examination of the eye revealed no other abnormality, and the patient was in perfect health.

From 1899 to 1909 the man lived in the Congo territory; at the latter date he returned to France. In 1906 he first became aware of the presence of the filaria in his right upper eyelid, from which position it disappeared in a few hours. After that date it returned on several occasions, always in the early part of the day, sometimes in the upper lid, sometimes beneath the conjunctiva, appearing near the caruncle and disappearing quickly towards the outer angle of the palpebral fissure.

During his sojourn in Africa the patient had had several attacks of malaria, but had been quite free from this malady since his return. Not infrequently, but at irregular intervals, he had noticed the appearance of very transient small tumefactions in the skin, which arose in various places. They were painless and underwent absorption in 2 or 3 days, leaving no trace. These were evidently the nodules commonly known as Calabar tumors, due to the presence of a filaria or to the action of a toxin secreted by the parasite.

The filaria beneath the conjunctiva was easily removed and proved to be a male; it measured approximately 5 cm. in length. Several examinations of the blood of the patient failed to discover any embryos (the filaria divina), but the blood showed a well marked eosinophilia.

The authors append a list of published cases of filaria loa in the eye, but this list does not include one of the earliest and most accurately reported examples, that of Argyll Robertson, published in the *Trans. Ophthal. Soc.*, 1895-1897. (Lawford in the *Oph. Review*, p. 279, Sept., 1914.)

The best account of this parasite will be found in the monograph by Henry B. Ward, who will furnish a further report in this *Encyclopedia* under **Parasites, Ocular.**

Filaria inermis Grassi. This species is chiefly found in the ass and horse, and has attacked the conjunctiva of man.

Filaria in the orbit. See **Parasites, Ocular.**

Filaria in the vitreous humor. See **Parasites, Ocular.**

Filaria medinensis Gurel. This species, according to Salzmann, has been found under the skin near the eye, but never under the conjunctiva.

Filaria oculi. Owing to its frequent invasion of the eye this term is occasionally applied to the filaria loa.

Filariasis. (L.) A chronic disease, often terminating in spontaneous recovery, caused by the presence in the system of one or other species of filaria: characterized by soft tumefaction of the inguinal glands,

hematuria or chyluria, and the periodical presence of the parasites in the blood.

Filar microscope. A microscope having cross-wires in its focus.

Filasse. (F.) Tow.

Filemot. (F.) A yellowish-brown or faded leaf color.

Filet. (F.) The ramifications of the smallest vessels and nerves.

Fili. (It.) Sutures.

Filicism. Poisoning from overdosage of extract of male-fern.

Filius Mesue. A mediaeval Arabian ophthalmologist. See **Abu Zakarija Juhanna b. Masawaih.**

Filix mas. Male fern. Aspidium. Male shield-fern. This is the dried rhizome of *Dryopteris (Aspidium) filix mas.* It contains filicic acid, filicin and other active ingredients—especially an active oleoresin. Dose: 2-8 grms.; Fl-ext. 2 to 6 cc.

The amblyopia from this agent has long been recognized. Parsons (*Pathology of the Eye,* p. 1340) thinks the visual disturbances caused by filix mas show resemblance to quinine amlyopia on the one hand and to lead poisoning on the other. Whether the toxic agent is filicic acid or aspidin and aspidinin remains uncertain, and there is also great divergence of opinion as to the toxic dose of the drug. Bokai puts the latter as low as 4 grms., whilst Sidler-Huguenin found that 20 to 45 grms. might be innocuous amongst the workers in the St. Gotthard tunnel. Probably the general health of the patient is the determining factor. Katayama and Okamoto found ocular symptoms in 32.5 per cent. of cases of filix poisoning, and 35.7 per cent. in dogs. Maj found 2 cases of blindness amongst 70 people. Sidler-Huguenin in 78 cases found 12 deaths, 18 bilateral and 15 unilateral blindness, 4 bilateral and 1 unilateral permanent amblyopia, and 1 bilateral and 3 unilateral transient amblyopia. The amblyopia generally involves the whole field, thus accounting for the striking absence of details of the condition of the fields in the recorded cases. Quite a considerable proportion of the cases are unilateral, but too much stress must not be laid upon this fact, since the other seldom escapes entirely, especially in the early stages.

The chief ophthalmoscopic feature observed is extreme pallor of the disc with sharply-defined edges. In transitory cases the ophthalmoscopic picture may be normal. In many cases the retinal vessels show abnormalities, especially constriction. Anatomically in experimental cases Masius and Mahaim found perivascular infiltration and breaking up of the myelin sheaths in the optic nerve, particularly in the neighborhood of the optic foramen. Marked retinal changes—bright white spots, etc.—have been observed, but it is known that

filix mas may cause nephritis, and these changes may be secondary to this complication. No post-morten examination in man has been reported, but there is a large literature of experimental observations on animals. The most extensive changes are recorded by Nuel, but the most accurate are those of Birch-Hirschfeld, who, using the delicate Nissl method, found chromatolysis in the retinal ganglion cells and in the cells of the inner nuclear layer. Degenerative changes are found in the optic nerve, attributed by some to the degeneration of the ganglion cells, by others to the direct action of the poison. Masius and Mahaim, again, attribute the cellular changes to defective nutrition following the vascular disorder. In any case there can be little doubt that the lesion is essentially peripheral. There is only slight evidence of a specific action upon the sympathetic system, but it is not disproved.

Schoening (*Zeitschr. f. Augenh.*, March, 1908) records a case of bilateral filix mas amaurosis, in a patient to whom the drug was administered for the expulsion of intestinal worms. He considers as notable the facts that the patient was a young, robust man, that no preparatory weakening treatment had been used, that he possessed no idiosyncrasy toward the drug, as was shown by a previously well-borne treatment with the same remedy; that no castor oil was administered afterward as a laxative; and further, that ophthalmoscopic examination was made within seven hours after the appearance of the visual disturbance, which at first manifested itself as contracted arteries and dilated veins, but later by a peculiar folding of the retina, probably dependent upon edema. The first perception of light appeared in the left eye 14 days after the blindness, and not in the center, as Nieden says is the rule, but in the periphery. A case of poisoning by extract of male fern is also reported by von Krüdener (*Arch. d'Ophtal.*, p. 716, Nov., 1908), who thinks the drug acts on the ganglionic layer of the retina.

Perrod's patient (*Ann. di Ott.*, xli, p. 17, 1912) had taken 135 grains of male fern at night, and 90 grains on rising, with a saline purgative. The following morning he was completely blind. The ophthalmoscope showed papilledema which was succeeded by atrophy. Loss of sight was permanent. See, also, **Toxic amblyopia.**

Film preparations. In bacteriology a method of examining discharges and secretions. For example, Hanford McKee (*Oph. Record*, Jan., 1912) describes slides for demonstrating the presence of the gonococcus. With an ear curette the palpebral conjunctiva is gently stroked, and the material spread carefully over a glass slide. It is then dried in the air, and fixed in 80 per cent. alcohol for ten minutes and then

stained with Giemsa solution, one to twenty parts of distilled water, for twenty minutes. In each of these cases where, by examining the pus, the results are negative, the epithelial cells are found crowded with biscuit-shaped diplococci.

Filtering scar. Filter cicatrix. Cystoid cicatrix. Especially in certain glaucoma operations it is considered essential that a satisfactory drainage path shall be established between the anterior chamber and the subconjunctival space, or even that the discharge occur upon the external bulbar surface. It was at one time thought that this process was osmotic in character, through the thinned cicatricial tissues of the (operation) wound. Now it is known that in such procedures as the Lagrange and Elliot operations successful drainage occurs by way of minute openings or *fistulettes*. See **Glaucoma.**

Filter, Wood's. See **Wood's filter.**

Filtration angle. Iridocorneal angle. Angle of the anterior chamber, important in glaucoma and other ophthalmic diseases.

Filtration chemosis. Filtration edema. This occurs when the aqueous humor escapes beneath the conjunctiva through a fistula at the sclerocorneal junction.

Filtration, Ocular. The reader is referred to incidental discussions of this subject under various headings, especially under **Circulation of the intraocular fluids** (page 2256, Vol. III, of this *Encyclopedia*); **Glauccma; Tension** and allied captions.

To the information there given it may here be said that one of the best demonstrations of the process of ocular filtration as it occurs in the lower animal eye, is furnished by the experiments of Uribe Troncoso (*Annales d'Oculist.*, Oct., 1909). This observer devised an ingenious method by means of which the amount of aqueous secreted can be accurately measured, and the paths by which the secretion leaves the globe can be made visible to the naked eye. Experiments made by means of his appliances go to support Troncoso's views, that Leber's estimates of the rate of filtration made with the manometer are unreliable. For the purpose of his experiments Troncoso found that rabbits' eyes were very suitable owing to the ease with which they can be luxated from the orbit.

The animal having been fixed, and the lids and neighboring parts shaved and disinfected, the eye is dislocated forwards by means of forceps traction applied to the conjunctiva and the superior rectus. The conjunctiva is then cut all round the limbus and separated from the sclerotic as far back as the equator. The recti may be cut or not as desired, as that makes no difference in the experimental results. The eye is held in position by the closure of the lids behind it, but

this may be made more secure by a stitch through the lids near the canthus. The slight hemorrhage having been allayed the eye is plunged into a glass cup, a little larger in diameter than the eye, containing pure olive oil, and held vertically below the eye, which is so arranged that the cornea looks downwards.

The glass cup is connected below with a horizontal graduated tube —which, however, is not generally used for measuring the amount of secretion. This is clamped to a stand which holds the whole arrangement in position. The eye is immersed as far as its equator in the cup whose edge is made to fit the orbital margins accurately by means of a rubber membrane having a perforation just large enough to admit the globe. This membrane is not absolutely necessary, but it has the advantage that it more completely isolates the eye and keeps out any liquids oozing from the lids and conjunctiva, though it interferes somewhat with the view of the changes at the limbus.

A few minutes after the immersion of the eye in the oil the slight hemorrhage from the limbic vessels becomes arrested, but continues a little time longer from the muscular vessels, from which two or three big drops hang down, and after about ten minutes let fall into the oil large drops of slightly rose-tinted lymph. The aqueous also escapes in the form of very small transparent drops arranged in a circle like a string of pearls around the corneal limbus. These generally fuse and also fall into the oil, but occasionally they have to be shaken off by stroking the eye with a spatula. Both large and small drops gravitate to the bottom of the cup and form a clear or slightly rose-colored globule. Its volume is further increased by detaching the liquid and clots, still adherent to the eye, by stroking with a spatula or by means of forceps. The oil and the exudate are centrifugalized so that all the fine drops dispersed through the oil join the rest of the lymph, which is then measured in a graduated tube and its respective ingredients estimated. As a rule the lymph is allowed to exude for half an hour to an hour. The experiments can be repeated after the eye has been cleaned and fresh oil placed in the cup. In the repeated experiments the amount of blood and fibrinous clot is negligible.

Troncoso finds that the rate of filtration in the same eye is remarkably uniform—about 5 cubic millimetres per minute—but the rate of filtration in the eyes of different animals may vary from 3 to 8.9 cubic millimetres per minute.

As the amount of blood and fibrinous clot varied in different animals careful calculations for these factors had to be made in each case. The liquid in the graduated tube forms three layers, viz., (1) blood-clot; (2) aqueous humor and blood serum mixed; (3) very small

layer of fibrinous clot. To find the amount of pure aqueous humor the quantity of serum which represents the amount of blood-clot registered is subtracted from the reading of the second layer. The relative quantity of corpuscles and serum in the rabbits' blood is determined beforehand by means of a hematocrite, or, more accurately, by running blood direct from a vein in the rabbit's ear into a graduated tube containing oil. When centrifugalized the relative amount of corpuscles and serum can be read off. The average amount of serum to clot is 62 : 100.

The technique of the experiments is such that the slight traumatism incurred in no way invalidates or impairs the accuracy of the results. This ocular demonstration of filtration in the living eye disposes of the doubts expressed by Weiss and Abadie, as to the existence of intraocular currents and the constant secretion and excretion of aqueous, and confirms the classical views on the subject.

The amount of aqueous excretion varies with intraocular pressure, and the secretion of the ciliary processes is dependent on the intravascular pressure. The discharge of lymph by the canal of Schlemm results from a veritable filtration through the membrane which forms its inner wall, and is due, as all filtration, principally to the pressure of the filtering liquids, which varies with intraocular pressure. The latter is the result of two factors—(1) the blood pressure in the uveal and retinal vessels; (2) the secretion of aqueous humor. The second is in direct relation to the first, but this relationship is not absolute, and the eye retains a certain autonomy of tension according to the quantity of liquids it contains. As the author has already pointed out (*Annales d'Oculistique,* February, 1907), intraocular tension may fall when the uveal blood supply is abnormal, as in the terminal stages of plastic or serous iridocyclitis. On the contrary, excretion and secretion are normally so well balanced that intraocular tension remains the same, notwithstanding variations of blood pressure.

The paths of aqueous excretion include not only the canal of Schlemm, but also the anterior surface of the iris, as shown by Nisel and Benoît, but it is highly probable that the spaces of Fontana and the canal of Schlemm represent the anatomically and physiologically specialized path, and that under normal conditions the whole excretion passes this way. Assuming this to be correct, and that secretion and excretion are approximately equal, the experiments show that the average secretion in a rabbit is 5.2 cubic millimetres per minute.

By cauterizing the anterior ciliary vessels the amount of lymph excreted was found to be 2.1 cubic millimetres per minute, and this may

be regarded as the quantity passing through the perforating vessels at the limbus.

In one abnormal case the transudation at the limbus was practically absent, and the rate of filtration was 2.9 cubic millimetres per minute, which closely represents the quantity discharged by the anterior ciliary veins.

An examination of the blood in the anterior ciliary veins also shows that the proportion of serum to corpuscles is much higher than it is in blood taken from other parts of the body, indicating that there is a decided admixture of aqueous humor in the former.—(J. Jameson Evans, *Oph. Review*, Feb., 1910.)

Filtrationswinkel. (G.) Filtration angle.

Filzlaus. (G.) Pediculus pubis.

Finder. In microscopy, any device enabling one to find easily some object or part in a microscopical preparation. It may consist simply of a ring painted around the object, of verniers on the stage of the microscope, or of a glass slide ruled in squares for registering the position of the microscopical specimen when the object is in the field. Then by putting the slide back in the same position on the stage of the microscope the object will be in the field. Frequently, as with a telescope, an objective of low power is used to find the object and get it into the middle of the field, where it can be found easily by the high objective. (Foster.)

Fine adjustment. The adjustment of an optical instrument by means of a micrometer screw.

Finger mirror. A mirror attached to the finger by a clasp.

Finger-piece eyeglasses. See **Eyeglasses and spectacles, History of.**

Finite rays. For practical purposes it is assumed that (and this name is given to) rays of light that come from a less distance than six metres.

Finne. (G.) Cysticercus.

Finsen lamp. Finsen light. The concentrated light produced by this lamp is *(Extra Pharmacopeia)* violet and ultra-violet. It is produced by an arc lamp in which the heat rays are cut off. Finsen's original lamp has been improved, and is known as the "Finsen-Reyn" lamp. It is portable, suitable for one patient at a time, and Finsen acknowledges its efficacy.

Fluorescent substances, e. g., esculin (5 minims of a 5 per cent. solution) injected immediately beneath the skin to be treated are sometimes used as adjuvants.

The rays obtained from carbon electrodes are more effective than those given off by iron ones. The current used in the lamp has a

strength of 40 to 80 amperes and an electromotive force of from 45 to 50 volts. Rock-crystal lenses are employed which allow of the complete passage of the ultra-violet light.

Trachoma, chronic, simple granular lids and many other eye diseases have been reported as cured or improved by this agent, but the Editor has not been able, after a fair trial, to corroborate this evidence.

However, several observers appear to be much impressed by the light as a therapeutic agent. Among them Grönholm and Heiberg (Graefe's *Archiv f. Ophthalm.*, Vol. 80, 1, pt. 1) treated 72 patients (400 sittings) for six months. A small area of the conjunctiva was treated at a time for a period of from 5 to 40 minutes and a sitting lasted from one to two hours. (Trachoma.)

The most rapid improvement was obtained by using the light about a week after a previous expression of the granulations. Considerable reaction follows, lasting two or three weeks, and leaving a smooth pale surface with scarring more superficial than that produced by copper sulphate. As a rule one application sufficed, in a few more obstinate cases up to six were required. In many cases the treatment was completed in a month.

After a year 60 of the eyes were reported on, of which over 50 per cent. were still healthy. The remainder showed recurrence, most frequently in cases which had been in an advanced state of the disease with considerable shrinkage of the conjunctiva when the treatment was begun.

In several cases corneal complications occurred, or when present, were aggravated.

The authors conclude that the Finsen light has a special power of destroying the trachomatous tissue and is in this respect distinctly superior to copper sulphate.

Lunsgaard (*Klin. Mon. f. Augenheilk.*, Dec., 1911, p. 763) also reports good results from Finsen's light in 20 cases of lupus and primary tuberculosis of the conjunctiva, without injury to the eyeball and without relapses.

One of the important discoveries made by Finsen was that it is the blood in the skin which absorbs most of the ultra-violet light. Sunlight ultra-violet can penetrate blood-filled skin only a fraction of a millimeter. But if the skin is made anemic by the pressing out of the blood, bacteria can be killed by the ultra-violet light which has passed through 4.25 millimeters of skin.

Finsen, Niels R. (1861-1904), discoverer of the curative power of the chemical rays of light (sunlight, electric light, Röntgen rays, etc.) and founder of phototherapy, was born in the Faroe Isles, and

taught anatomy at the University of Copenhagen. He has shown that the effects of light upon biological processes are due almost exclusively to the chemical, or violet and ultra-violet, rays of the spectrum. The Finsen lamp, which is employed to destroy certain pathogenic organisms, as in lupus, favus, ring-worm, and alopecia areata, concentrates the rays of an electric arc lamp by means of a lens composed of one flat and one curved disc, between which is interposed a solution of copper sulphate. In 1903 he was awarded the Nobel prize for medicine.—*(Standard Encyclopedia.)* See his *Chemical rays and variola* (1894); also *Phototherapy*.

Fiolax glass. Glass free of alkaline salts, and when tinted supposed to act as a protection to the eye from excess of actinic rays.

Fire-gazers. This term was probably first introduced into ophthalmology by Nettleship (*Trans. Oph. Soc. U. K.*, Vol. 32, p. 388, 1912), who referred to dogs that look steadily into a fire at close range, and are, in consequence, liable to get the cornea encroached upon by black pigment. In one such case which he saw the cornea was covered with what appeared to be a melanotic deposit. It was only on the surface, and there was no central thickening; nothing like a tumor.

Firemen, Railway, Examination of the eyes of. See **Eyes of soldiers, sailors, railway and other employees, Examination of the.**

First aid in ophthalmic surgery. The emergency treatment of urgent eye symptoms—traumatic lesions especially—often falls to the general practitioner and not infrequently to the layman. Those ophthalmologists who lecture to nurses, lay members of Red Cross societies, and other semi-professional organizations, are advised to read M. Buchanan's First Aid to the Injured Eye (*Woman's Med. Jour.*, Feb., 1911), as well as the caption **Injuries of the eye** in this *Encyclopedia*.

First-base character. In alphabets and print for the blind (q. v.), this is a character having a dot or dots in the first vertical column only. A second-base character has dots in the first and second vertical columns only. Third-base characters, fourth-base characters, etc., may be similarly defined.

First intention. An immediate union in which the surfaces of the wound become glued together by an albuminous fluid and the wound heals without further redness, swelling, or the formation of pus.

First principal focus. See **Focus.**

Fischer, Johann Friedrich Christoph. A German physician, surgeon and ophthalmologist, especially celebrated as an operator for cataract. Born at Erfurt, April 9, 1772, he became at first an apothecary, in which capacity he lived for a time at Wetzlar, Mainz, Blankenhain, and Erfurt. Turning his attention to medicine, he studied at Jena

and Erfurt, at the latter institution receiving his degree. After a considerable period of military service he studied again, at Vienna, and, settling as a physician, but chiefly as an ophthalmologist, in his native city, Erfurt, he founded there, in connection with a minister, an "Institution for the Blind and for Eye Patients." He died Sept. 14, 1849.

Fischer's most important (or only) ophthalmologic writing was "Einige Bemerkungen über das Verhältniss der Extraction des Grauen Staares zur Keratonyxis hinsichtlich der Gefährlichkeit," etc. (Langenbeck's *Neue Bibliothek,* 1819.)—(T. H. S.)

Fischer, Johann Nepomuk. The founder of modern ophthalmology in Bohemia. Born at Rumburg, Bohemia, May 29, 1777, he received his medical degree at Vienna in 1806. Later, he became Professor of Ophthalmology at the University of Prague, and the first physician ever appointed to the Prague Ophthalmic Institute. He was chiefly active as a teacher and operator, but wrote: "*Lehrbuch der Gesamten Entzündungen und Organischen Krankheiten des Menschlichen Auges, Seiner Schutz- und Hilfsorgane*" (Prague, 1846).—(T. H. S.)

Fischer, Waldemar Edward. A well-known St. Louis ophthalmologist, of great promise, who died young. He was born at St. Louis, Mo., Sept. 13, 1877, son of Dr. Joseph A. Fischer, a dentist, and Alma C. Fischer. His medical degree was received at the Marion Sims College of Medicine, St. Louis, in 1898. He then took a special course in ophthalmology at Berlin, Germany, and Vienna, Austria, from 1899 till 1901. Returning to St. Louis, Fischer became an assistant in the eye clinic of the Marion Sims College, and at the American Medical College, the Medical Department of the National University. He was also ophthalmic surgeon at the Missouri Baptist Sanitarium.

He was a man of impressive presence, tall and lean, with dark complexion and very dark eyes and hair. He was quiet, earnest and dignified in his manner, and made many friends.

When only thirty-seven years of age, Dr. Fischer, being seriously ill from overwork, committed suicide, Jan. 9, 1915. The circumstances of this tragical occurrence, as well as a number of further particulars concerning the Doctor's work and personality, appear in the following quotation from the St. Louis *Globe-Democrat:* "Dr. Waldemar E. Fischer, 37 years old, an oculist with offices in the Wall Building, committed suicide yesterday at his home, 3634A Connecticut Street, by asphyxiating himself with illuminating gas. A nervous breakdown due to overwork is ascribed by his father, Dr. Joseph A. Fischer, of the same address, as responsible for the suicide.

"The father informed the police that his son had been overworked,

and that, on Dec. 25 last, he had closed his office intending to go to Asheville, N. C., to take a rest.

"Dr. James Moores Ball, dean of the Medical School of the National University of Arts and Sciences, said yesterday: 'The death of Dr. Waldemar Fischer is a distinct loss to ophthalmology. While his contributions to the literature of this branch of medical science were not numerous, he had in him much promise, and the articles which he did write were beyond adverse criticism.

"'His paper on "Coloboma Maculæ Luteæ," published in the *Annals of Ophthalmology,* January, 1906, was quoted in scientific journals all over the world.'

"Dr. Fischer also wrote the chapter on 'Methods Employed in the Microscopic Examination of the Eye' for Ball's '*Modern Ophthalmology.'* Dr. Ball said that this chapter was one of the best in his work.

"Dr. Fischer was a man of the highest integrity, and politeness under any and all conditions was one of his chief characteristics. The word gentleman describes him completely.

"He was a generous man, and much of his work was done for charity."—(T. H. S.)

Fischvergiftung. (G.) Poisoning from (decomposed) fish.

Fishes, Eyes of. The eyeballs of fishes are rarely spherical, owing to their flattened cornea. There are no movable eyelids, but sometimes the eye is provided with fixed dermal folds, evidently the analogues of lids. In the mackerel and the herring a transparent membrane partially surrounds the eye, while in some sharks there is a well-defined, movable, nictitating membrane drawn over the cornea, as in birds, by adductor muscles. The sclera is well developed; externally of fibrous tissue, internally a cartilaginous layer, which, as in the sturgeon, is sometimes very thick. In the bony fishes this layer of cartilage is further stiffened at the corneal border by two osseous plates. In some cases these plates, as in birds, form a complete ring about the cornea. The piscian choroid is composed of several layers; externally one notices the silvery sheen of the *tunica argentea,* a thin areolar tissue layer studded with crystals. In the dogfish, sharks, etc., and the cartilaginous ganoids, occurs a true light-reflecting *tapetum.* In the osseous fishes is found the so-called "choroid gland," a large, horseshoe-shaped organ placed in the neighborhood of the optic nerve. These animals also exhibit the *processus falciformis,* often described as a fold of the choroid, the analogue of the pecten in birds and attached, like it, within the eyeball along the optic nerve entrance.

Referring to a few of the questions involved in the visual apparatus and eyesight of fishes, R. W. Wood (*Johns Hopkins University Circu-*

lar, April, 1906) remarks that a human eye below the surface of water sees the sky compressed into a comparatively small area of light, the center of which is always immediately above the observer, the appearance being as if the pond were covered with an opaque roof with a circular window cut in it. Surrounding objects appear around the rim of the circle of light, but of these we are unable to get a clear notion, since our eyes are not adapted to clear vision under water. By immersing a camera in water and photographing the circle of light we can get an idea of how these things appear to the fish. A number of interesting pictures were obtained with a device equivalent to a lens having a working angle of 180 degrees. A pin hole in place of the lens gives even better definition. The apparatus in a horizontal position represents things as seen by a fish looking through the glass sides of an aquarium. The cone of light entering a fish's eyes has an aperture of about 96 degrees, but the rays within it came originally from a cone of 180 degrees. Thus, all three sides and the complete ceiling and floor of a room may be photographed, or when placed at a point where four streets meet at a right angle we can get a view looking down any three streets, the view including the ground up to the base of the tripod and the sky from the horizon to the zenith. Suspended from a balloon, it will photograph the entire surface of the earth out to the horizon in all directions. There is a good deal of distortion near the circumference of the circular picture. See, also, **Blind fishes**; as well as **Comparative ophthalmology.**

Fish-poisoning. The toxic effects of certain ptomaines formed in decomposing fish. The symptoms are choleraic, paralytic, or exanthematic. With the first there are vertigo, headache, pallor, thirst, abdominal pain, diarrhea, and anuria; with the second the preceding symptoms are present, as well as mydriasis, ptosis, decrease of body temperature, weakness of the heart's action, and eventually coma and death. In the exanthematic form there are fever and an erysipelatous eruption, followed by desquamation. See **Toxic amblyopia.**

Fissile. Susceptible of cleavage.

Fission. A mode of generation or of cell-division in which the organism separates into two or more equal parts, each of which becomes developed to the size and form of the original.

Fissura facialis. A name for congenital lachrymal fistula. The opening probably corresponds to the nasal pouches of fishes and the lachrymal sinus of several of the higher vertebrates. See **Congenital anomalies of the eye.**

Fissura palpebrarum. (L.) The space between the eyelids.

Fissure. A groove or cleft. A term applied to the clefts or grooves in various organs.

Fissure, Ammon's. During the early fetal period, a pyriform fissure in the lower portion of the sclerotic coat of the eye.

Fissure, Calcarine. A fissure on the mesial aspect of the cerebrum, extending from near the occipital end and joining the occipital fissure; it is collocated with the calcar or hippocampus minor. In this region is the cortical center for vision. See, also, p. 1356, Vol. II, of this *Encyclopedia* as well as **Neurology of the eye.**

Fissure, Choroid. See **Development of the eye.**

Fissure, Collateral. The inferior occipito-temporal, or collateral, fissure is a complete fissure which gives rise to the *eminentia collateralis* in the descending horn of the ventricle, and cuts deeply into the temporal and occipital lobes. It is closely related to the cortical visual centre.

Fissure, Fetal ocular. In the embryonic eye, a fissure in the thick wall surrounding the lens. A coloboma results if it be not closed.

Fissure, Infra-orbital. Suborbital fissure. Spheno-maxillary fissure. A fissure in the superior maxillary portion of the floor of the orbit, the upper termination of the infraorbital canal.

Fissure, Interpalpebral. Palpebral fissure. Interpalpebral aperture. Interpalpebral space. The space between the eyelids, extending from the outer to the inner canthus.

Anomalies of shape, size and situation of this space are involved in such affections as blepharophimosis, epicanthus, ankyloblepharon, ptosis, ectropion, blepharospasm, lagophthalmos and entropion. Without added remarks on most of these subjects, all of which will be discussed under their proper headings, Elschnig (*Klin. Monatsbl. f. Augenheilk.*, p. 17, Jan., 1912) refers to the different processes which lead to shortening of the palpebral fissure without abnormal adhesions of the lid borders, for which alone the term ankyloblepharon must be reserved. In cases of true blepharophimosis the palpebral fissure is considerably shortened in the horizontal direction and the temporal commissure may, if the patient looks straight forward, touch or even surpass the temporal margin of the cornea. If the lids are opened wide, the palpebral fissure may be just as high as wide, and the temporal angle almost completely rounded. Genuine blepharophimosis occurs in old people, in whom the skin of the lids is of senile condition, wrinkled and easily movable. By a slight traction on the skin of the temple the normal position of the temporal commissure and the normal length of the palpebral fissure can be restored. By this possibility of instantaneous restitution the condition is distinguished from ankyloble-

pharon. Rudimentary blepharophimosis is very frequent in old people. According to von Michel, the affection is due to relaxation of the lateral palpebral ligament, or tarso-orbital fascia, and to contracture of the orbicularis muscle. The same condition is occasionally observed in normal elasticity of the lateral palpebral ligament at every forcible closure of the lids.

In trachoma two forms of true shortening of the palpebral fissure may occur. The first differs from senile blepharophimosis in that it is also observed in young persons, when it is due to softening of all tissues of the lids plus blepharospasm.

In the second and irreparable form a cicatricial blepharophimosis leads to a progressive stretching of the lateral palpebral ligament and to a displacement of the temporal canthus. True blepharophimosis is thus either senile, spastic or cicatricial. In its lighter degrees it has only a cosmetic significance; in the more intense forms it may interfere with vision towards the side.

Lateral epicanthus (congenital or spastic), is a winglike protraction of the temporal lid-skin over the lateral canthus, produced by spastic contraction of the orbicularis muscle.

Elschnig has also observed in two out of 50,000 eye patients an abnormal length of the palpebral fissure. This seems to be a congenital affection. In none of the cases did the exposed conjunctiva give rise to irritation.

Veasey describes *rhythmic alterations in width of the palpebral fissure* (*Ophthalmic Year-Book,* p. 283, 1909) in a child subject to spasm of the levator. Cure followed correction of the hypermetropic astigmatism present, and administration of arsenic. Rhoads has also observed dilatation of the alæ nasi coincident with winking.

Fissure of Rolando. A depression in the occipital lobe of the brain.

Fissure of the canthus. A disagreeable and frequently painful condition, generally of the outer commissure. See **Canthus, Fissure of the.**

Fissure, Sphenoidal. The sphenoidal fissure, or *foramen lacerum anterius,* is a slit-like opening between the greater and lesser wings of the sphenoid. It transmits the third, fourth and sixth nerves; the frontal, nasal and lachrymal branches of the ophthalmic, or first division of the fifth nerve; filaments from the cavernous plexus of the sympathetic nerve, the orbital branch of the middle meningeal artery, the recurrent lachrymal artery, and the ophthalmic vein.—(J. M. B.)

Fissure, Spheno-maxillary. This opening forms the external boundary of the floor of the orbit. It is formed chiefly by the orbital plate of the superior maxillary bone, with a small part of the malar in front and the orbital plate of the palate bone behind. It transmits the

superior maxillary nerve and its orbital branch, the infra-orbital vessels, and ascending branches from Meckel's ganglion. By means of the spheno-maxillary fissure the orbit communicates with three fossæ: the temporal, zygomatic, and spheno-maxillary.—(J. M. B.)

Fistel. (G.) Fistula.

Fistola. (It.) Fistula.

Fistula, Capillary, of the lachrymal sac. A fistulous opening into the lachrymal sac caused by the rupture of an abscess of that cavity. See **Capillary fistula of the lachrymal sac.**

Fistula, Corneal. See page 3367, Vol. V, of this *Encyclopedia.*

Fistula, Lachrymal. See **Lachrymal apparatus, Diseases of the.**

Fistula of the lachrymal gland. This lesion may occur from trauma, dacryops, or abscess, or it may be present as a congenital condition. The fistula opens on to the upper lid, and presents a minute orifice through which tears ooze forth. Under excitement or irritation the flow becomes profuse. The closure of such an opening is sometimes difficult, and, if the effort succeeds, it may cause dacryoadenitis. The older ophthalmologists resorted to heroic measures. Beer closed a fistula by passing a red-hot knitting needle into the opening, and Mackenzie used a probe coated with lunar caustic. The simplest and most satisfactory way to deal with such cases is to excise the lachrymal gland, and at the same time cut out the tissue around the fistulous tract. Fistulæ due to caries or necrosis of the orbital wall will heal only after the removal of the diseased bone.—(J. M. B.)

Fistulation. Formation of a fistula for remedial purposes—as in the eyeball for the relief of glaucoma.

Fistulette. Capillary or small fistula. This term is generally used to designate the microscopic canals that penetrate the scar-tissue following operative wounds for the relief of glaucoma.

Fistulous staphyloma. A synonym of fistula of the cornea. See p. 3367, Vol. V, of this *Encyclopedia.*

Fitiriasi delle palpebre. (It.) Pityriasis of the lids.

Fitow's test. In this case the Snellen or some other form of test type is shown to the individual suspected of ocular malingering one letter at a time, characters of smaller dimensions than those which correspond to the distance from the patient being chosen in each instance. The distance from the test chart is then greatly diminished but always to a less degree than the size of the types. True malingerers are almost certain to betray themselves while reading the letters, especially if they pretend a unilateral amblyopia.

Fitting and adjusting glasses. See **Eyeglasses and spectacles, Mechanical adjustment of.**

Fitting of artificial eyes. See page 626, Vol. I, of this *Encyclopedia.*

Five-leaf. POTENTILLA. Cinquefoil was highly recommended by the ancient Greeks and Romans as a remedy in almost all diseases of the eye.—(T. H. S.)

Fix. See **Fixation.**

Fixate. To render, or to become, fixed. A synonym of *fix,* to gaze at; also used in the sense of *fix,* to render immobile in a preservative fluid.

Fixation. Worth (*Squint,* p. 3) reminds us that in the centre of the retina is the macula lutea, which, in the human eye is far more sensitive to ordinary visual impressions than any other part. It is desirable, therefore, that the eye be brought into such a position that the image of any object which especially engages our attention shall be formed upon the macula lutea. The eye is then said to "fix" the object.

The same writer also says that in a case of monolateral convergent squint, if the fixing eye be covered the vision of the (previously) deviating eye temporarily ceases to be suppressed. In a fairly recent case this eye is then directed so as to receive, upon its macula lutea, the image of the object looked at. But if the case be long neglected, this sensitive central region of the retina suffers much more from disuse than the paracentral zone, while the peripheral region suffers very little, if at all. As the blindness progresses in this disused eye, a stage is at length reached when the visual acuity of the central region falls below that of the paracentral zone, and later, even below that of the periphery of the retina. If the fixing eye be now covered, the deviating eye is not directed so as to receive upon its macula the image of the object which engages the attention, because the macula has ceased to be the most sensitive part of the retina. This eye then wanders without remaining steadily in any definite position *(lost fixation).* Or it may fix with some part of the paracentral region, or roll still further in towards the nose so as to present the extreme nasal periphery of the retina for the purpose *(false fixation).*

Fixation, Field of. In optics, the region bounded by the utmost limits of distinct or central vision, and which the eye has under its direct control through its excursions, without movements of the head. See **Field of fixation.**

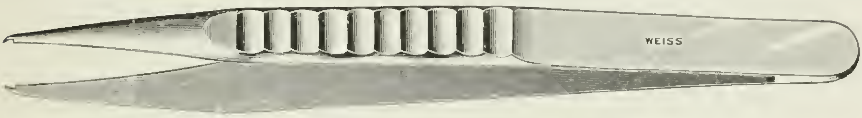
Fixation-forceps. An instrument used for fixing or holding a part, the eyeball, in position, for instance, during a surgical operation. See the following heading.

Fixation instruments. OPHTHALMOSTATS. FIXATION FORCEPS. FIXING FORCEPS. As stated in the Editor's *System of Ophthalmic Operations,*

Vol. I, page 201, by far the commonest instrument for this purpose is the well-known fixation forceps provided with three or four teeth. The latter should not be, as they often are, provided with sharp points

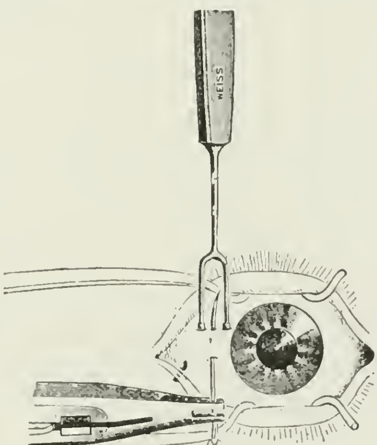
Allport's Fixation Forceps.

or cutting edges, as they lacerate the tissues. The purpose of the forceps is to grasp the soft parts and not to cut them. Elschnig (*Augenärztliche Operationen*, 2nd Edition, Vol. I, p. 6) recommends (see



Bader's Fixation Forceps.

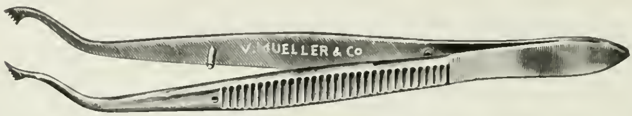
the figure) a straight forceps provided with three teeth, one blade with one tooth, the other with two, set at an angle of 45 degrees. When the blades are placed about two mm. apart near the sclero-corneal



Batten's Fixation Fork.
The sclera is held above while a needle is introduced from below.

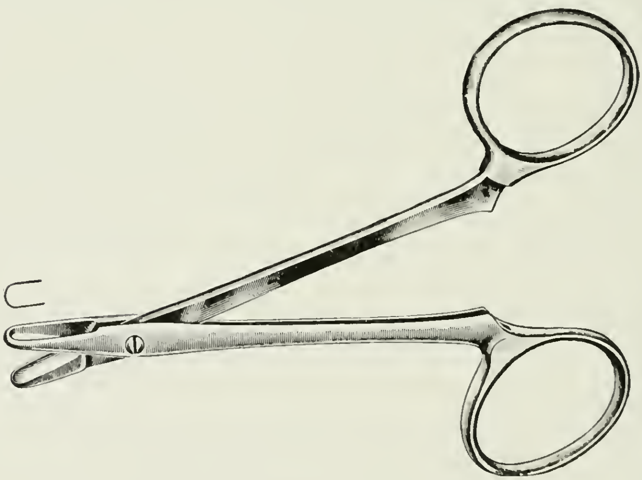
junction, gently pressed against the globe and then closed, the episcleral tissues are caught in the teeth without damaging them, yet fixing the eye securely.

The fixation forceps are generally placed close to the limbus because the conjunctiva in that situation is less moveable than elsewhere. If the operator should tear the mucous membrane and still desire fixation, the underlying scleral tissue, or even the tendon of a straight muscle can be grasped, but the latter method is a painful one and to be avoided as much as possible. Apart from ignorance or care-



Barr's Fixation Forceps.

lessness this accident is most likely to happen when the patient is under a general anesthetic and the operator attempts to drag in the opposite direction an eyeball that has rotated beyond his reach. It

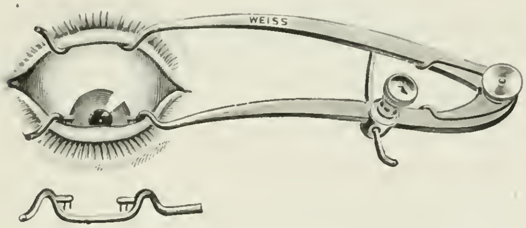


Boettcher's New Chalazion Forceps.
(See, also, p. 1992, Vol. III, of this *Encyclopedia.*)

is not to be forgotten that gentleness, quite as much as firmness, is a part of ophthalmic operations.

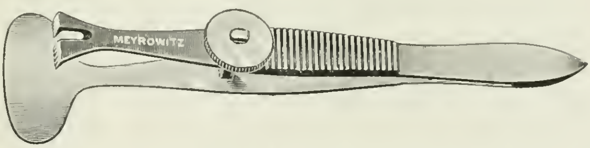
Generally the teeth of the fixation forceps are placed on the opposite and corresponding part of the globe to the point of puncture. In the corneal incision of cataract extraction with an upper flap the area of fixation is best chosen a few mm. below the meridian of the counter-puncture so that the knife, as it cuts its way out, may not come in contact with the forceps.

The assistant should particularly bear in mind while holding the fixation forceps that neither pressure nor dragging movements should be made upon the eyeball. The purpose of the forceps is to steady



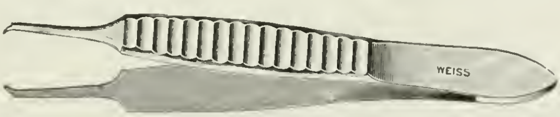
Brailey's Eye Speculum for Fixation.

or fix the globe as securely as possible without injury to its tissues or discomfort to the patient. If it is necessary to rotate the globe the patient should be requested to look in the required direction while the forceps, although held in their closed condition, should simply



Combined Lid and Fixation Forceps.

follow the globular movement. If the patient be under a general anesthetic, or if for any other reason he cannot look in the required direction, the eyeball may be rotated, not pulled or pushed, the forceps being always held at the same tangent to the globe. When it is desirable to fix the eyeball with greater security than usual, as for



Critchett's Fixation Forceps.

example in trephining the cornea, two forceps are employed, one at each end of the same corneal meridian. These are held in each hand of the same assistant. Double fixation forceps have been devised for this purpose, but in general these are not very satisfactory, because it is difficult to secure equal fixation with the two sides of the forceps, and there is more apt to be unnecessary and perhaps dangerous trac-

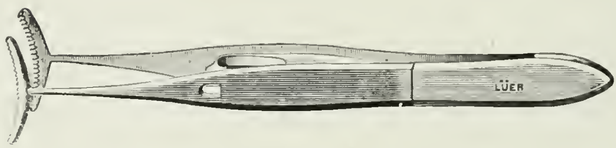
tion on one side or the other if there is a sudden and unexpected movement of the eyeball.

There is, as a rule, not only no need for a catch, or lock, in the

Desmarres' Fixation Instrument. (Serretelle.)

fixation forceps, but they are generally a nuisance if not a positive danger, because too much valuable time is wasted in applying and releasing them.

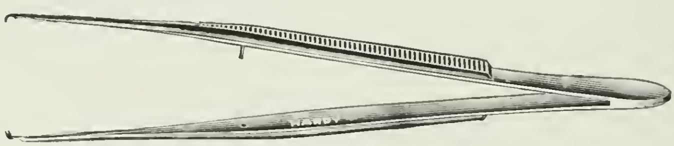
If there is a particular objection to making even the slightest wound



Dujardin's Forceps, without Spring.

in the conjunctiva and no special reason for securing fixation of the globe, as in tattooing the cornea, a blunt forceps may be used—one provided with serrated ivory, celluloid or hard-rubber terminals.

In some cases, as in enucleation of the globe, operations on the vitreous, etc., where forceps are inconvenient, a needle and thread are



Elschnig's Straight Fixation Forceps.

passed through the conjunctival and episcleral tissues at the limbus and brought out about a cm. from the point of entrance. The ends of the suture, which may be about 23 cm. long, are held by the assistant who can easily rotate the globe to any desired condition.

In the following pages and illustrations other methods and instruments for fixing the eyeball will also be found described.

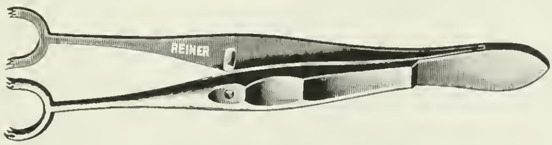
The purpose and modus operandi of many of these instruments are indicated by the accompanying illustrations and their legends;

in which case they are passed over without other mention of the use for which they are intended. Among these may be described the fix-

Ewing's Fixation Forceps.

ing instruments of Bader, Critchett, Dujardin, Ewing, Reiner, Leiter, Monoyer, Noyes, Schweigger and Streatfeild.

Frank Allport (*Ophthal. Record*, Aug., 1913) has devised a pair

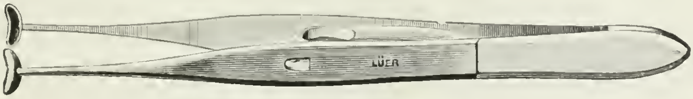


Fork-pronged Forceps, without Catch. (Reiner.)

of fixation forceps without teeth, but with serrated or roughened points that hold the conjunctival tissues firmly, but do not tear or pierce them.

George's Fixation Forceps.

Batten's fixation fork is a useful instrument, especially when it is necessary to push a needle—particularly a large needle or one without cutting edges—through the tough and resisting sclera. The cut illustrates the method of its employment.



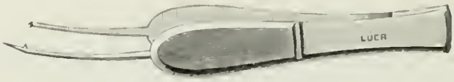
Gradenigo's Fixation Forceps, with Spring and Catch.

This instrument belongs to the type of non-penetrating devices. A fold of conjunctiva is simply grasped (not cut or otherwise injured) by the terminals whose shape conforms to the outline of the eyeball.

Barr's fixation forceps has curved blades for ready application to the globe in the presence of a prominent nose and orbital margin.

Beard's fixation forceps are made on the principle of de Wecker's

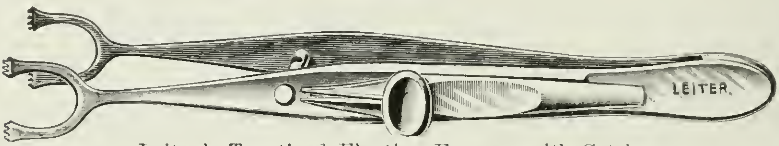
scissors and grasp the eyeball in virtue of "closing in" on it, instead of taking hold in the usual fashion from above. See page 918, Vol. II, of this *Encyclopedia*.



Heymann's Claw Forceps.

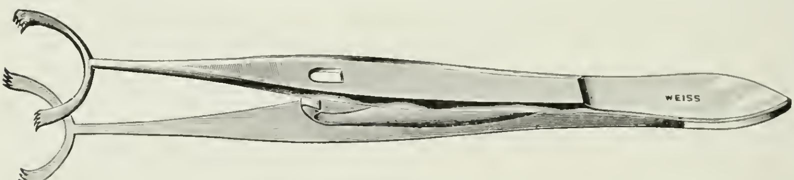
This instrument is provided with one sharp-pointed blade that enables it to secure a more complete bulbar fixation.

Brailey's fixation speculum was designed to obviate the difficulty which is experienced in fixing the eye in various operations, such as cataract extraction or iridectomy. With this instrument an assistant may be dispensed with.



Leiter's Two-tined Fixation Forceps, with Catch.

The fixation speculum consists of the particular pattern usually favored by the surgeon, with the addition of two arms on the lower blade, each bearing two rounded spikes. To insert this, the upper



Monoyer's Fixation Forceps.

blade is first put into place under the lid, and then the points on the lower blade are pressed against the conjunctiva, just external to the corneo-scleral junction, about 3 mm. from the lowest part of the cor-

Pamard's Fixation Point or Spear.

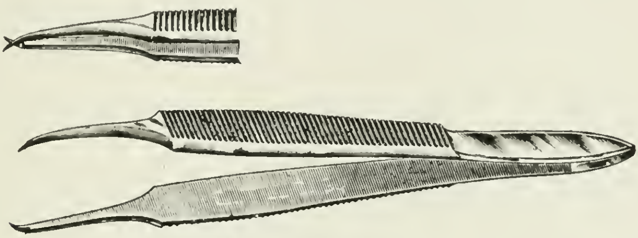
nea; next, the blade is put into position behind the lower lid, so rotating the eye down and holding it there, leaving the hands of the surgeon free for the operation.

To remove it the upper blade is taken out first.

Combined lid and fixation forceps. In many operations on the lid, notably in the removal of cartilage in chronic trachoma cases, it is

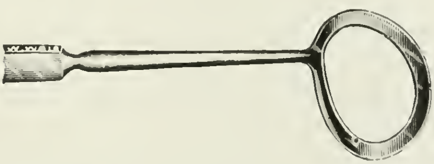
Noyes' Fixation Forceps.

usual to employ both a lid plate of some kind and a fixation forceps in addition. The instrument here presented is a combination of the



Prince's Fixation Forceps.

two and has been employed with great satisfaction at the New York Eye and Ear Infirmary for several years.



Schöler's Fixation Instrument for Tattooing.

Fork-pronged forceps. This is a two-tined instrument and used like other fixation devices for steadying the eyeball during operations

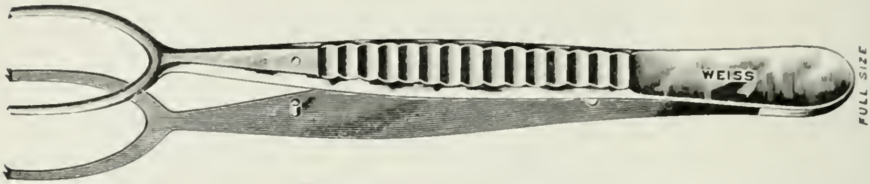
Schweigger's Fixation Bident.

on the globe. There are several of these instruments figured in the text.

Schöler's fixation instrument, employed in tattooing the cornea.

not only holds but protects that portion of the globe not intended to be reached by the tattooing needle.

For further information regarding the use of fixative inventions,



Streatfeild's Fixation Forceps.

see the text of such captions as **Iridectomy**; **Cataract, Senile**; **Cataract, Intracapsular extraction of**; as well as **Glaucoma**; **Trachoma**, and especially **Instruments, Ophthalmic.**

Fixation-line. LINE OF FIXATION. In *physiologic optics*, the line which connects the center of the object viewed with the center of motility of the eyeball.

Fixation speculum. See **Fixation instruments.**

Fixation test. This term is generally construed as meaning a test of binocular fixation for near. The patient is told to observe the surgeon's finger placed at 13 inches from and on a level with the eyes. The finger is then advanced slowly toward the patient's nose to within 3½ inches (8 centimetres). If one eye turns outward, there is exophoria. The test is a rough one, and its chief value is in determining which of the interni is the weaker.

Fixator. An ophthalmostat or fixation instrument (q. v.): for steadying or fixing the eyeball during an operation on or examination of it.

Fixed bodies is a term applied in chemistry to those substances which are not volatilized at moderately high temperatures. Fixed oils are those oils which, on the application of heat, do not volatilize without decomposition.

Fixed cataract. An obsolete term used to distinguish an immovable opaque lens from one that trembles or oscillates.

Fixed cells (of the cornea). These are found in the lymph spaces of the cornea. See **Histology of the eye.**

Fixed focus. That point in the axis in the field of a lens through which all objects situated beyond a certain distance from the lens are approximately focused.

Fixiergabel. (G.) Fixation fork, or bident.

Fixing eye specimens. See **Laboratory technique and museum preparations.**

Fixing forceps. See **Fixation instruments.**

Fläche. (G.) Plane; surface.

Flachensarcom. (G.) Flat sarcoma.

Flacon compte-gouttes. (F.) Drop bottle.

Flag-signaling. See *Signaling.* **Eyes of soldiers, sailors, etc.**

Flajani, Joseph. A celebrated Italian surgeon and ophthalmologist of the 18th century, especially famous for his work in connection with the artificial pupil and the treatment of dacryocystitis. He is sometimes said to have been the discoverer of exophthalmic goitre, which affection, therefore, is now and then designated by the term, "Flajani's disease." Flajani, however, cannot, in any proper sense, be said to have discovered the malady in question, which is far more properly known as "Graves' disease" and "Basedow's disease." (See in this *Encyclopedia,* **Graves** and **Basedow.**) All that Flajani did was to describe in Vol. III, at p. 270, of his "*Collezione d'Osservationi e Riflessioni di Chirurgia,*" (1802) three cases of bronchocele accompanied (among other symptoms) by palpitation of the heart. He seems to have had no clear idea either that the goitre caused the palpitation, or that both the palpitation and the goitre might have been engendered by some common cause. Flajani was born in 1741, near Ascoli, received the degree of Doctor of Philosophy and Medicine at Rome, settled in that city, there became surgeon at the Hospital San Spirito, as well as body physician to Pope Pius VI, and died Aug. 1, 1808.

Hirschberg gives the year of Flajani's death as 1802, probably a mistake, inasmuch as both Hirsch and Lippincott's "*Biographical Dictionary*" agree on 1808. Probably Hirschberg, when he wrote "1802," had still in mind the date of Flajani's book.—(T. H. S.)

Flajani's disease. Although the main features of exophthalmic goitre have been universally connected with the names of Graves, Basedow and Parry yet Flajani, earlier than any of the foregoing, recognized a few signs of the malady but did not—clearly at least—realize that they form part of a symptom-complex that corresponds to a generally well-defined disease. See **Flajani.**

Flame gauge. An instrument for measuring the intensity of a flame.

Flame-shaped marginal epithelial keratitis. This form of corneal disease was (probably) first described and named by W. T. Holmes Spicer (*Trans. Oph. Soc. U. K.*, Vol. 32, p. 386, 1912), who reports a case of a cook, æt. 26, whose eyes had been inflamed on and off for about four years.

Spicer found slight punctuate staining of the cornea with fluorescein at the lower part only. These proved to be a number of superficial, gray, slightly-raised, pointed fingers or flames, starting

with their base at the limbus and reaching rather more than a third of the way across the cornea; some of these are split at their bases or in their whole length; they are broader in the right than in the left eye, and less clearly defined in the latter owing to the scraping. There is no staining of the flames as a whole."

Spicer believed the flame-shaped elevations to be due to exposure to the heat of the fire, because after the patient had had a holiday and went home there was no disturbance of the kind, but when she returned to work the condition recurred. He had never seen any material change in the flames. When she first came for advice she had slight angular conjunctivitis, and the conjunctiva had always seemed slightly red. The flames were superficial, and in staining they did so not as a whole, but in a punctate way. The left eye had been scraped, when it was somewhat better in consequence. Once or twice she had had a filament hanging from the cornea. There had never been deep irritation in the eye.

Flap-extraction. Daviel's method of cataract extraction. It was improved by Beer, and consists in making a semicircular flap (upward in Daviel's, downward in Beer's) in the cornea, or at the margin, with rupture of the capsule and expression of the lens. This method, since revived, with modifications, has been adopted by a number of operators. See **Cataract, Senile.**

Flaps in eye surgery. The uses of skin, conjunctival mucous, lip and other forms of the flap in ophthalmic operations are discussed under the various headings to which they properly belong—such as **Blepharoplasty; Cornea, Ulcer of the; Injuries of the eye.** A full account of *conjunctivoplasty* in the treatment of perforating ulcer of the cornea will be found on page 3508, Vol. V, of this *Encyclopedia.* The reader is also referred to an excellent article on the protection afforded by a double conjunctival flap by L. M. Francis (*Trans. Oph. Sec. A. M. A.*, June, 1913) in penetrating injuries of the sclera.

Flare. A blurred or fogged portion on a developed plate, generally due to reflection of light within the camera.

Flarer, Francesco. A celebrated Italian ophthalmologist, especially remembered as the inventor of Flarer's operation for trichiasis (q. v. in this *Encyclopedia*). The dates of his birth and death are not procurable. He became, however, professor of ophthalmology at Pavia in 1819, as well as director of the Pavian Ophthalmic Hospital. His best known writing is "*Riflessioni sulla Trichiasi sulle Distichiasi e sull' Entropio Acuto, Particolare Riguardo ai Metodi di Jaeger e di Vacci*" (Milan, 1828).—(T. H. S.)

Flarer's operation. See **Entropion.**

Flaschenkürbis. (G.) *Lagenaria vulgaris* (q. v.), or bottle-gourd.

Flat eye. A vulgar name for hypermetropia.

Flatness of field. The absence of appreciable curvature in the field of a lens.

Flat sarcoma. Ring sarcoma. Annular sarcoma. This rather rare form of malignant neoplasm may affect the whole ciliary body, but it is usually found in the choroid. A good account is given by Wescott (*Trans. Am. Oph. Soc.*, 1912), who describes the disease and gives a history of two examples of this tumor. Herbert Parsons (*Archives of Ophthal.*, Vol. 33, 1904) reported a case of ring sarcoma of the ciliary body and iris, and reviewed the literature of diffuse sarcoma of the uveal tract. He recorded 35 cases, including his own, but regarded two cases reported by Schiess in 1864 and 1865, and two reported by Hirschberg in 1869 and 1870, as probably inflammatory and not to be counted. A. N. Alling and Arnold Knapp reported a case of ring sarcoma of the ciliary body, and reviewed the literature of that variety of the diffuse sarcomata. They refer to nine cases, including their own, four of which are described by Parsons, "in which a diffuse growth was present in the form of a complete ring, involving the ciliary body and apparently originating therein." In addition to the 40 cases referred to in these two papers, Arnold Knapp reported a flat sarcoma of the choroid, and Paul G. Woolley, a flat tumor of the ciliary body and choroid *(Johns Hopkins Hospital Bulletin)* in 1905; E. E. Henderson, a flat sarcoma of the choroid *(Trans. Ophthalmological Society, U. K.)* in 1908; Harold Goldberg, a diffuse tumor of the entire uveal tract (*Annals of Ophthalmology*, 1909), and H. Luedde, a diffuse tumor of the choroid (Graefe's *Archiv*) in 1909, making 45 cases in all.

To Fuchs has been given the credit of first distinguishing between diffuse and circumscribed sarcomata of the uveal tract and he reported three cases in 1882. De Wecker, however, in 1876, in the Graefe-Saemisch *Handbuch*, stated that in two cases such a diffuse tumor had been seen. In 1894 Mitvalsky reported two cases, and first used the very descriptive term, "Flächensarcom." Ewetzky in 1898 first used the term "ring sarcoma" to describe those tumors confined to the ciliary body and encircling the eye. A study of the recorded cases shows that the sexes have been about equally affected. The youngest patient was twelve and the oldest seventy-two years old. In many of the cases the disease was evidently of long duration —from seven months to ten years. There is a history of injury or operation in quite a percentage, the trauma dating from nine weeks to seven years before the discovery of the tumor. In most of the

cases glaucoma was present, but was not constant in all. Parsons calls attention to the fact that a number of the eyes were enucleated because of absolute glaucoma, and the tumor was discovered in the laboratory. Goldberg suggests that many eyes excised for glaucoma may contain flat sarcomata which are not discovered. In his case there was no suggestion of tumor before operation, and no macroscopic evidence of it on section of the globe. Extra-ocular extension occurs frequently, sometimes early, is often multiple, and follows the perivascular lymph-channels through the sclera. All observers have been impressed by the tendency of these tumors to infiltrate the tissues, as opposed to the formation of a definite tumor. Parsons is of the opinion that they are endothelial in origin. He bases his opinion upon the character of the cells, the frequency of an alveolar arrangement, the tendency to myxomatous degeneration and necrosis, and the ease and rapidity with which they invade the lymph-spaces of the neighborhood. See, also, **Tumors of the eye.**

Flat-spring kymograph, of Fick. A narrow U-shaped tube connected with a blood-vessel by means of a cannula, and over the expanded free extremity is a caoutchouc membrance with a projecting point pressing against a horizontal spring that is connected with a writing lever.—(Foster.)

Flattern. (G.) To flutter; to be irregular.

Flavescent. Becoming yellowish.

Flax. *Linum usitatissimum.* The juice of the flax was employed by the ancient Greeks and Romans as a sharpener of the sight; the seed, for ophthalmic inflammations.—(T. H. S.)

Flax-weed. *Linaria graca.* In ancient Greco-Roman times, the leaves of the flax-weed were employed as a poultice for "rheuma" (any kind or sort of discharging eye).—(T. H. S.)

Fleabane. *Plantagium psyllium.* Fleabane was recommended by the ancient Greco-Roman physicians for epiphora. The leaves were simply laid upon the forehead.—(T. H. S.)

Flea-glass. An early form of the simple microscope, with a plano-convex lens.

Flecke. (G.) Spot; macula.

Fleischfliegen. (G.) Meat flies.

Fleischgift. (G.) Fleischvergiftung. Ptomaine poisoning from decomposed meat.

Fleischl von Marxow, Ernst. A celebrated German physiologist, pathologist and physiologic optician. Born at Vienna Aug. 5, 1846, he studied at Vienna and Leipsic, at the latter institution receiving his degree in 1870. In 1880 he was extraordinary professor of physiol-

ogy at the University of Vienna, and, seven years later, corresponding fellow of the Viennese Academy. He died Oct. 22, 1891. A likeness in relief of this physiologist was unveiled in the Arcades of the University of Vienna Oct. 16, 1898, on which occasion a memorial address was delivered by Exner.

Fleischl von Marxow's most important writings are: "*Die Doppelte Brechung des Lichtes in Flüssigkeiten*" and "*Die Deformation der Lichtenwellenfläche in Magnetischen Felde.*" A complete collection of his works was published by Exner in 1893, together with a portrait of this distinguished physiologist and optician.—(T. H. S.)

Flema salada. (Sp.) Literally, salty phlegm; in the north of Spain, an epidemic disease formerly supposed to be pellagra, but having the features of acrodynia, and now attributed to eating diseased grain. It occasionally presents indefinite eye symptoms.

Flemmone. (It.) Phlegmon.

Fles' box. A test for ocular malingering. See **Fles's test**; as well as **Blindness, Simulation of.**

Fles, Joseph Alexander. A distinguished Dutch ophthalmologist. Born at Breda in 1819, he received the degree of Doctor in Medicine in 1843 at the University of Utrecht. In 1851 he was appointed docent for descriptive and pathologic anatomy at his alma mater, and in 1862 for ophthalmology. In 1868 he severed his connection with the University, and devoted himself to private practice as an ophthalmologist until his death.—(T. H. S.)

Fles' sches Kästchen. (G.) The Fles box-test for ocular malingering.

Flesch, Jacob Gustav Adam. A German physician, who devoted considerable attention to ophthalmology. Born at Frankfort-on-the-Main June 2, 1819, he studied at Heidelberg and Berlin, at the latter institution receiving his degree in 1839. His dissertation, on this occasion, was "De Glaucomate." He practised in Frankfort from 1841 until his death, Nov. 28, 1892.—(T. H. S.)

Fles's test. The Fles' box. This was one of the earliest, as it is one of the best, devices for making the alleged blind eye see an image which the malingerer imagines he is seeing with his good eye. It consists of a rectangular box in which two mirrors of a definite size and orientation are placed vertically with an inclination of one hundred and twenty degrees. The small dimensions of the apparatus, causing prolonged efforts of accommodation before the images are found, and the images being formed so near to one another that they have a tendency to blend, produces a lack of precision in the answers of the patient. Consequently, with the object of rendering the plan more practical, Fles's box has undergone many modifications. Barof-

fio inclines the mirrors at one hundred and twenty-five degrees; Binnedijk and Armaignac make them movable on a hinge in such a way as to vary the angle which they form, and to obtain such relations of the images that, without closing one of the eyes, it is impossible to know which is the image perceived by the right eye and which is seen by the left eye.

Fleur. (F.) Flower.

Flexile collodion. FLEXIBLE COLLODION. This useful agent is made from one part of pyroxylin (gun-cotton), 12 parts of 90 per cent. alcohol, and 36 parts of ether. It is a useful solvent of iodoform, cantharides, salol, salicylic acid and other agents. Both pure and mixed with one of these remedies it is commonly used in wounds and other injuries about the eye. As a protective for operations upon the lid-skin it is often invaluable. Flexible collodion contains Canada turpentine and castor oil, and makes a more elastic film than the older contractile collodion. (See, also, **Camphoid.**)

Formalized gelatin is largely used in Great Britain as a substitute for collodion. Ten per cent. gelatin solution in water is stored in wide mouth test tubes holding three ounces each. The tubes are plugged with cotton wool and sterilized at 100° C. for 15 minutes on three successive days. When required for use they are melted in a water bath and 1 drachm of formalin added. The mixture contains 2½ per cent. of commercial formalin.

Formalized gelatin is applied with a brush or swab on the top of the dressing beyond the limit of the wound and the dressing is thus held in place without a bandage. See, also, p. 2325, Vol. IV, of this *Encyclopedia.*

Flexure, The cranial. See **Development of the eye.**

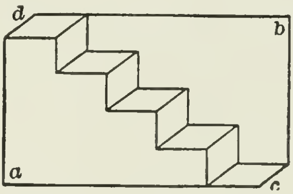
Flibbertigibbet. In English folk-lore, a fiend who causes, among other injuries, various diseases of the eye, especially strabismus. Thus, Shakespeare, "King Lear," Act III, Sc. 4 (1605): "This is the foul fiend Flibbertigibbet. He begins at curfew and walks at first cock; he gives the web and the pin [various ocular diseases: see, herein, **Web** and **Pin**], squints the eye, and makes the hare-lip; mildews the white wheat; and hurts the poor creature of the earth."—(T. H. S.)

Flicker photometer. This instrument is used both as a chromometer and light-intensity measurer. Its action is based on the principle that when two lights of different intensities are alternated with medium rapidity before the eye they produce a sensation of flickering that continues until the two lights are rendered of equal intensity. A

scale or index is provided for recording the illuminating power of the lights under examination. See, also, **Photometer.**

Fliege. (G.) Fly.

Flight of steps, Schröder's. An illustration of binocular vision. As Brodhun explains (*System of Diseases of the Eye*, Vol. I, p. 540) the picture in this text as producing at once the impression of a flight of steps against a wall, beginning at the right hand and ending at the left, this being so whether one looks at it with the line *ac* below, or, after turning it through an angle of 180°, with the line *bd* below. If the first impression be kept distinctly in mind while turning the picture upside down, an overhanging, stair-like piece of masonry leaning against a wall will be seen. If now the first impression be



Schröder's Flight of Steps.

recalled to mind, the object looked at will be suddenly transformed into a flight of steps beginning at *d*. Moreover, while before the impression predominated that the surface *a* was the nearer to the eye, the surface *b* will now appear the nearer. After some practice, either impression can be produced at will.

Flimmerleiste. (G.) Ciliary body.

Flimmerscotom. (G.) Scintillating scotoma—in migraine.

Flint glass. A variety of optical glass made of silica, lead and potash in proportions of about 1/2, 1/3 and 1/6, respectively, but varying in different specimens. The admixture of lead increases the density and the refractive power of the glass, which is also softer than *crown glass* having a lesser refractive index. The name *flint glass* originated with the use of flint, from which the silica was first made in England. The difference in the refractive and dispersive powers of flint and crown glass is utilized to secure achromatism in prisms and lenses, and which in the latter is effected through cementing together two contra-generic lenses whose curvatures are so proportioned that the chromatic dispersion produced by one lens is counteracted by the other. For instance, the curvatures of a *convergent* lens of flint glass and a *divergent* lens of crown glass with a different power may be so chosen as to produce the *same dispersion* in *opposite directions* for

a *fixed line* in the spectrum, while their combined contra-generic and unequal refractive powers still afford an available refractive power of desired amount in the so created *achromatic lens*. See **Achromatism.** —(C. F. P.) See, also, **Glass.**

Flittene. (It.) Phlyctenules.

Flocculent cataract. (Obs.) A false cataract. An exudative, fibrinous opacity like a fine network in the area or field of the pupil.

Floccn. (F.) Flake.

Floh. (G.) Flea.

Floor of the orbit. See page 401, Vol. I of this *Encyclopedia.*

Florascope. A botanical lens.

Flores cinæ. Flowers of the *Artemesia pauciflora,* from which santonin is extracted.

Florpapierversuch. (G.) Flower-paper experiment.

Flower-paper test. HEIDELBERG OR MEYER'S FLOWER-PAPER EXPERIMENT. In perimetry, to mark the limit for a white object it suffices to note the places where the patient gets the sensation of the appearance of a light spot. For the determination of the peripheral limits of colored objects the sensation of color must be present. Instead of Förster's slide, which makes a sound, and by it informs the patient of the approach of the test-object, dull-black rods, fifty centimetres long, to the end of which the object is fastened, can be substituted. The test objects generally employed are white and colored squares of five millimetres each. The colored objects are made of so-called Heidelberg flower-paper. For the examination of high grades of amblyopia, white and colored squares of ten, twenty, and more centimetres' side-length are often necessary for employment. Likewise squares of one or two millimetres' side-length for the discovery of small central defects in the field of vision are of value. See **Perimetry.**

Flowers of zinc. See **Zinc oxide.**

Fluctuant. Wavering.

Fluer. (F.) To flow or run from an organ.

Flügelfell. (G.) Pterygium.

Flügelförmiges Augenfell. (G.) Pterygium.

Fluid cataract. See **Cataract, Morgagnian.**

Fluid compass. A magnetic compass in which the weight of the card is partly neutralized by its immersion in a fluid.

Fluid lens. A hollow lens filled with a refractive fluid.

Fluoresce. To be, or to become, fluorescent.

Fluorescein. FLUORESCIN. RESORCINOLPHTHALEIN ANHYDRIDE. $C_{20}H_{15}O_6$. This salt occurs in yellowish or yellowish-brown crystals obtained by fusing 7 parts of resorcin and 5 parts of phthalic anhydride. It is slightly soluble in water and ether; very soluble in alcohol with a

yellow-green fluorescence. It forms variously colored solutions (so-called fluoresceids or fluoresceinates) with ammonia, liquor sodæ and liquor potassæ.

Whether used alone or in combination with potassium or sodium solutions, this stain for corneal abrasions and ulcers exhibits beautiful tints of yellow and green. Benson in early tests with the salts concluded that when a cornea stains in whole or in part, the stained part represents either (1) an ulcer not yet covered with epithelium; or (2) an abrasion of epithelium; or (3) epithelium in a dead or diseased condition, though not necessarily in a dying state. The fact of staining is not therefore to be in all cases taken as an indication for active treatment (though this doctrine is often taught), for in many cases an ulcer which stains is nevertheless healing quite satisfactorily, and the fact of the epithelium taking on the stain is not necessarily an indication that an ulcer will certainly form.

After trials of the various preparations of fluorescein, the Editor finds that a 2 per cent. solution of potassic fluoresceide (potassium fluoresceinate, Merck), dropped on the cornea without the preliminary use of cocain and after subsequent gentle cleansing of the parts with sterile water, or a borated solution, forms the best method of employing this valuable reagent. The test is further robbed of its objections if the patient closes his eyes for a few minutes after the instillation and all superfluous stain be then washed off by flooding the eye with sterile water.

He prefers the following formula: Fluorescein., gr. viii (grm. 1.1); liq. potassæ, f℥ss (grm. 2.0); aquæ dest., f℥i (30.00).

Allow this to stand for ten days in a cool, dark place and then filter. For diagnostic purposes instill a single drop into the conjunctival sac or allow it to fall on the cornea. Close the eye for two minutes. Gently irrigate the globe and sac with warm normal salt solution or a 2 per cent. boric acid mixture. The stain is a bright yellow-green which accurately maps out the disturbed area and does not irritate the most sensitive eye.

Uranine, the sodium salt of fluorescein, very soluble in alcohol and water, may be used like the potassium compound, but, in the Editor's judgment, it is not so satisfactory. It is a yellow-brown powder and interesting because of its use as a test of death. If 15 grains (1 grm.), dissolved in water, be injected into the human body the scleræ will be stained green within an hour, if life still exists.

Under the name *cariblen*, C. Bruck (*Niederl. Ophthal. Gesellsch.*, June 14, 1914) advised the use of a fluorescein-uranin-silver preparation in gonorrheal diseases. Following this hint L. K. Wolff (*Münch.*

Med. Wochenschr., Sept. 29, 1914) has used a similar combination with zinc (instead of silver) which he finds very useful against the Morax-Axenfeld bacillus. See **Fluorescin-zinc.**

Fluorescence is the property possessed by some transparent substances of becoming self-luminous when exposed to the direct action of light-rays. A fluorescing substance is one which rejects or throws back to the eye rays of light of a color or wave-length quite different from the color or wave-length of any of the rays originally falling upon it. The phenomenon was first observed by Sir David Brewster and Sir John Herschel, but Sir George Stokes in 1852 was the first to discover its real nature. He filled a test-tube with a dilute solution of quinine sulphate, placed it just outside the red end of a pure spectrum of the sun's rays, and then slowly moved it along the spectrum to the other end. Nothing was observed until the violet portion was reached, when a ghost-like gleam of blue light shot right across the tube. Stokes found that most organic substances show signs of fluorescence. Barium platinocyanide, which is used in the fluorescent screens employed in work with the Röntgen rays, shows a brilliant green fluorescence with ordinary light. Phosphorescence and fluorescence are the same phenomena, the one difference being in the longer duration of the former. Fluorescence ceases when the incident radiation is withdrawn; phosphorescence continues for a longer or shorter time. No satisfactory or complete theory of fluorescence has yet been offered. Some bodies fluoresce in the solid state, but not in solution, others only in solution. Fluorescence is always associated with absorption; but on the other hand many bodies are absorbent without being fluorescent. The most recent theory is that of Voigt, who bases his explanation on the theory of electrons.—*(Standard Encyclopedia.)*

Fluorescence, Lenticular. That the human crystalline exhibits a peculiar bluish-white fluorescence was observed by Helmholtz. Among others, A. Vogt (*Klin. Mon. f. Aug.*, 51, I, February, 1913, p. 129) has investigated this phenomenon in individuals of from 1 to 75 years, on about 40 fresh lenses of human cadavers, on recently extracted cataracts and on many lenses of calves and cattle of different ages. All lenses were placed on porcelain dishes and exposed to different kinds of rays, viz.: ultra-violet, violet, blue (adulterated by violet and green), violet-blue (adulterated by green), and to violet+blue+ultra-violet (adulterated by red and green). In this way he corrected and supplemented our knowledge of fluorescence of the lens. He finds that Helmholtz's observation of the whitish-blue fluorescence of the lens is only conditionally correct.

He believes that human and bovine lenses fluoresce in whitish-blue color in the ultra-violet of the arc light. This whitish-blue is modified and tinted yellowish-green, if it is filtered through yellow lens substance, which weakens its blue and violet components. The degree of this modification depends on the intensity of the yellow coloration of the lens and its thickness, as well as on the intensities of the fluorescence and the admixed ultra-violet. Violet light produces fluorescence only in yellow lenses. Colorless lenses, e. g., of the calf, transmit violet unaltered and therefore do not fluoresce. But the human lens always fluoresces in violet, even in earliest infancy, on account of its yellowish coloration. Thus the fluorescence of the lens shows that without absorption there is no fluorescence. The fluorescent light of violet varies from yellowish-green to yellow. The fluorescent light of blue is of slight intensity. It depends on the absorption of the exciting light, requiring a more intense yellow coloration of the lens than that of fluorescence by violet. This fluorescent light contains no ultra-violet nor violet components. In the light nebula produced by ultra-violet the yellow color of the lens can be perceived entoptically. Objective proof of the presence of the lens in the eye is furnished by means of fluorescent light, in cases in which this is impossible by any other method, e. g., in pupillary exudations. The visual disadvantages ascribed by Schanz and Stockhausen to the fluorescence of the lens do not exist. In daylight the fluorescence cannot be perceived both objectively and subjectively. The diffuse light nebula in radiation with ultra-violet light is not identical wth the fluorescence of the lens, as asserted by Schanz and Stockhausen, but only a small part of it. Vogt shows that it is also caused by rays which do not produce fluorescence. (*Ophthalmology* review, p. 593, July, 1913.)

Von Sepibus (*Zeit. f. Augenh.* v. 29, p. 407, 1913) comments on the difference of opinion as to the exact color seen by various observers of the fluorescent lens. He attributes these discrepancies to the fact that each writer has adopted a different method for inducing fluorescence. He himself uses a Schott uviol glass plate, 6 mm. thick, which absorbs all light except ultra-violet, blue and a little red. He also tried Lehmann's ultra-violet filter, which practically allows only ultra-violet rays to pass. The source of light used was a Finsen apparatus, which gives a light exceedingly rich in ultra-violet rays. With the ultra-violet filter the fluorescence of the human lens was very slight, although discernible, and had a blue tinge. With the uviol glass filter he obtained a greenish-yellow fluorescence, which was more marked in old than in young lenses. In normal hog lenses Chalupecky (*Wiener klin. Woch.*, v. 63, pp. 1902 and 1913, 1986)

was able to produce changes analogous to those of senile cataract, by exposing them for three hours to the action of a quartz lamp; and he regards his findings as further illustrating the chemical influence of ultra-violet rays on the crystalline lens.

Fluorescent eyepiece. A form of eyepiece used in examining the ultra-violet spectrum made visible by fluorescence.

Fluorescin-zinc. The double transposition of a potassium fluorate and zinc sulphate resulted in the production of a fluorescin-zinc compound. This is a reddish-yellow powder, soluble in water only in 1 to 1000 solution, and contains 15.8 per cent. of zinc. With this compound L. K. Wolff (*Münch. Med. Wochenschr.*, p. 2002, 1914) treated ten patients with true Morax-Axenfeld conjunctivitis by distributing this finely powdered substance onto the conjunctiva and following it by light massage. All the patients were cured by one, or at the most two, applications within from twenty-four to forty-eight hours, and the only disadvantage manifest was the green discoloration of the tears for twenty-four hours.

Experimentally the compound proved to have a higher bactericidal power than zinc sulphate or any of the astringents in common use. Wolff attempted to decide whether the success of the compound was due to bacteriacidins, described by Schneider, but was unable to find the presence of these bodies at all. He believes that the more rapid effect of the drug is due to its continued action upon the infecting organisms. As the compound is only slightly soluble, it remains for a long time in the conjunctival sac and consequently its action is prolonged.

Fluornatrium. Sodium fluoride.

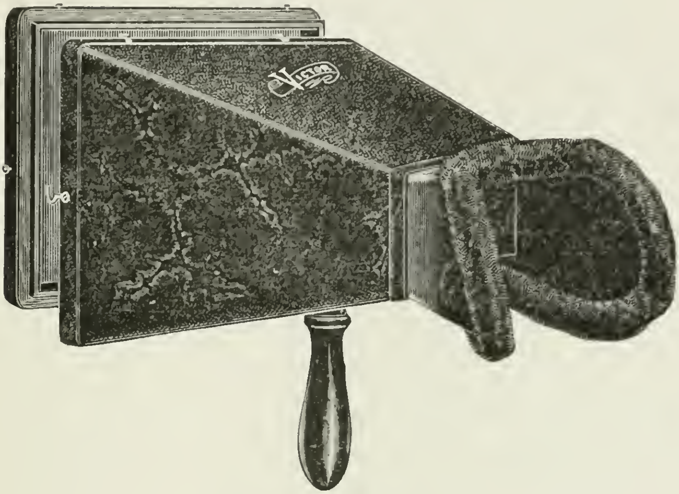
Fluorcl. Sodium fluoride. Clear white crystals or powder. It is sometimes used as an antiseptic dressing in wounds (5 to 10:1000) and is also given internally (gr. 1/12 — 1/5) as an antispasmodic in epilepsy and malaria. A 1:200 to 400 solution is recommended by Duclos for washing out the lachrymal sac in dacryocystitis, especially as it is decidedly antiseptic without causing irritation. (See *Centralbl. f. pkt. Augenheilk.*, p. 726, 1906.)

Fluorcmeter. A device for adjusting the shadow in skiagraphy; a localizer in X-ray examination.

Fluoroscope. Cryptoscope. A device for holding the fluorescent screen in X-ray examinations, while inspecting tissues or an organ.

In the Victor fluoroscope there is a small lead-glass shield which fits in the instrument, being placed behind the screen but in front of the eyes; this does not obscure the image on the screen, but is a

protection to the eyes. In addition to this an opaque, impregnated rubber apron is attached at a point on the fluoroscope just in front of the handle and hangs in such a position as to protect the hand and lower part of the operator's face. See the cut. See, also, **X-rays.**



Victor Fluoroscope.

Fluoroscopy. The process of examining the tissues by means of a fluorescent screen.

Fluor-spar. Native fluoride of calcium.

Flüssigkeit. (G.) Fluid; fluidity.

Fluted spectrum. A spectrum consisting of a number of broad luminous bands, sharply-defined at one edge, and shading off gradually at the other edge. When examined by a spectrometer of great dispersive power, each fluting is found to consist of a considerable number of lines, closely packed toward the definite edge of the fluting, and more and more widely spaced as the blurred edge of the fluting is approached.

Fly. (Gr. *Muia;* L. *Musca.*) In ancient Greco-Roman times, hordeolum, or stye, was treated by means of the musca, which probably (but not certainly) was identical with our modern house-fly. The head of the fly being removed, the body was rubbed vigorously against the hordeolum. Triturated flies were also rubbed on the eyebrows in order to make them blacker, and the ashes of flies, made into a salve with antimony, mouse-dung and wool-fat, was used to prevent the return of cilia after epilation.—(T. H. S.)

Focal. Of, or pertaining to, a focus; as, a *focal point* (see **Focus**). *Focal distance*, in *optics*, of a mirror or lens, the distance (also called the *focal length*) from its center to the principal *focus* (see **Focus**). *Focal interval*, see **Astigmatism.** *Focal line*, the locus of foci in an astigmatic pencil of light (see **Astigmatism**). *Focal plane*, a plane perpendicular to the optical axis, the locus of the foci of infinitely distant objects, with reference to points upon the principal axis of a lens (see **Axis**). *Focal point*, see **Focus.** *Elementary focal plane* contains the *principal focal line* of a cylindric lens when considered separately as one of the elements in a combination of two superposed cylindric lenses, and whose combined refraction produces two other focal lines which are located in the *primary* and *secondary* focal planes (see **Astigmatism**). The positions of the latter are respectively defined by the refractive powers in the meridians of greatest and least refraction of the combined cylindric lenses. In a monograph, "*Dioptric Formulæ (q. v.) for Combined Cylindric Lenses,*" New York, 1888, Prentice first published the following laws governing such combinations: 1. The primary and secondary planes (q. v.) of refraction are at right angles to each other for any angular deviation of the axes of two combined congeneric (q. v.) cylindrical lenses.

2. For combined congeneric cylinders of equal refraction, the primary plane equally divides the angle between the active planes of the cylinders, and the secondary plane similarly divides the angle between the axial planes of the cylinders.

3. For combined congeneric cylinders of unequal refraction, the primary plane, in dividing the angle between the active planes of the cylinders, will be nearer to the active plane of the stronger cylinder, and the secondary plane consequently nearer to the axial plane of the same cylinder.

4. When the axes of the congeneric cylinders coincide, the primary focal plane will correspond to that focal plane which is defined by the sum of the refractions of the cylinders, whereas the secondary focal plane will be at infinity.

5. The primary and secondary focal planes coincide with their correlative elementary focal planes, when the axes of the congeneric cylinders of unequal refraction are at right angles to each other.

6. The primary, secondary, and elementary focal planes all merge into one plane, when the axes of the congeneric cylinders of equal refraction are at right angles to each other.

7. The primary and secondary focal planes are conjugate planes, subject to variations of the angle between the axes of the congeneric cylinders.

8. For combined contra-generic (q. v.) cylinders of equal refraction, the plane of greatest positive refraction equally divides the angle between the active plane of the convex and the axial plane of the concave cylinder; and the plane of greatest negative refraction similarly divides the angle between the active plane of the concave and the axial plane of the convex cylinder.

9. When the convex cylinder is stronger than the concave cylinder, the plane of greatest positive refraction will be nearer to the active plane of the convex, while the plane of greatest negative refraction will be proportionately farther from the active plane of the concave cylinder.

10. When the concave cylinder is stronger than the convex cylinder, the plane of greatest negative refraction will be nearer to the active plane of the concave, while the plane of greatest positive refraction will be proportionately farther from the active plane of the convex cylinder.

11. When the convex cylinder is of greater refraction than the concave, and their axes are coincident, the positive focal plane will coincide with that focal plane which is defined by the difference (or sum of their refractions when taken as positive and negative elements) of the refractions of the cylinders, whereas the negative focal plane will be at infinity.

12. When the concave cylinder is of greater refraction than the convex, and their axes are coincident, the negative focal plane will coincide with the focal plane which is defined by the difference of the refractions of the cylinders, whereas the positive focal plane will be at infinity.

13. The positive and negative focal planes coincide with their correlative elementary focal planes, when the axes of the contra-generic cylinders are at right angles to each other.

14. The positive and negative focal planes are conjugate planes, subject to variations of the angle between the axes of the contra-generic cylinders.

15. The sum of the primary and secondary refractions is a constant, being equal to the sum of the elementary refractions for any combination, and all deviations of the axes of two combined congeneric cylinders.

16. The sum of the principal positive and negative refractions is a constant, being equal to the sum of the positive and negative elementary refractions for any combination, and all deviations of the axes of two combined contra-generic cylinders.—(C. F. P.)

Focal centers (of a lens). Two conjugate axial points located where

the incident and the emergent ray cut the optical axis when the refracted ray between the lens-surfaces passes through the optical center of a lens. The incident and the emergent ray are then parallel.—(C. F. P.)

Focal conic. A locus of foci of a quadric surface.

Focal curve. The locus of foci of a surface.

Focal depth. The penetrating power of a lens; the range through which the parts of an object, a scene, etc., projected by the lens are produced with satisfactory distinctness.

Focal disease. FOCAL LESION. This term was formerly used to designate a localized affection of the brain—tumor, abscess, etc. More recently it has become the fashion to employ the term, also, in referring to a circumscribed infected area or lesion from which toxins, etc., spread throughout the system or are carried to a distant organ.

Focalebene. (G.) Focal plane.

Focal illumination. The concentration in a darkened room, by means of a convex lens, of the flame of a lamp upon the object to be examined. See **Examination of the eye.**

Focal interval (of Sturm). See **Astigmatism.**

Focalization. The art or process of bringing to a focus, or of placing in focus.

Focalize. To bring to a focus; to focus.

Focal line. See **Focal.**

Focal lines. The lines, anterior and posterior, that bound the focal interval. See **Focal**; as well as **Astigmatism.**

Focal plane. A plane through the focus of a lens perpendicular to its axis. See **Focal.**

Focal points. The two principal foci of a compound dioptric system. See **Focal.**

Foci, Aplanatic. Aplanatic focal points. See **Aplanatic.**

Foci, Conjugate. See **Foci.**

Focimeter. An instrument for assisting in focusing an object in or before a photographic camera.

Foci. Plural of focus.

Focus; plural, *foci*. In *optics*, (introduced by Keppler in 1604), a point at which rays of light that originally diverge from one point meet again, or a point from which they appear to proceed. The former is called a *real*, the latter a *virtual* focus. A focus may be defined as the point to which a spheric wave converges, or from which it diverges. It may also be defined as the point at which little waves from all parts of a great wave arrive at the same time. (Airy, *Optics*, p. 44.) The *principal focus* of a lens is the focus of rays that are incident to the

lens parallel to its axis, and there are two principal foci, f_1 and f_2, respectively, on each side of the lens. An incident ray proceeding from the first principal focus (f_1 negative), or toward that point (f_1 positive) is rendered parallel to the axis after refraction through the lens; whereas an incident ray parallel to the axis gives rise to a refracted ray which virtually proceeds from the second principal focus (f_2 negative), or which actually passes through that point (f_2 positive); see **Convention of signs.** As parallel incidence corresponds to the second principal focus, the latter is universally used to designate and determine the *principal focal length*, f, of a lens whose refractive index is n, and whose radii of curvature are r_1 and r_2. Their relation to each other is: $\frac{1}{f} = (n - 1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$. In the case of a spherical mirror, the focal length f is one-half of the radius, or $f = r/2$. The *principal foci* are two points on the axis and on opposite sides of the lens, the one on the object-side in the *object-space* being called the *front focus,* the one on the image side in the *image-space* the *back focus.* Every lens which increases in thickness towards its periphery has virtual foci; and vice versa, for the focus of a lens to be real, the lens must be thicker in the middle than at the edge. Therefore, a concave lens produces a virtual, and a convex lens, a real image of the object. The *conjugate foci* of a mirror or lens are two points so situated that the rays emitted from a luminous body or illuminated object at either point are reflected (by the mirror) or refracted (by the lens) to the other. The equation expressing this relation, when u is the object-distance and v the image-distance from a *mirror,* with a radius r, is $\frac{1}{v} + \frac{1}{u} = \frac{2}{r}$. Similarly, for a *lens* whose focal length is f, the equation is: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$. When using these formulæ for numerical values of u, v, r and f, regard must be had for the continental **Convention of signs,** which see.—(C. F. P.)

Focus, Equivalent. In microscopy, when the real image of an objective of a certain focal length is of the same size as that produced by a simple converging lens whose focal distance equals that of the objective, it is said to have an equivalent focus. (Gould.)

Focus, First principal. See **Focus.**

Focusing cloth. A cloth thrown over the camera and the head of the

photographer when focusing, with the object of excluding any other light than that coming through the lens.

Focusing frame. In photography, the frame which holds the ground glass on which the image is focused.

Focusing glass. A simple microscope for determining when the image in a photographic or microphotographic camera is sharply focused on the ground-glass. The focusing glass is so adjusted that when its mounting is placed against the front or smooth side of the ground-glass or focusing screen of the camera an object or real image on the ground side, i. e., in the plane occupied by the film of the sensitive plate, will be in the sharpest focus possible. (Foster.)

Focusing screen. A contrivance by means of which the photographer adjusts the size and focus of the object to be photographed.

Focus, Negative. See **Focus.**

Focus, Real. See **Focus.**

Focustiefe. (G.) Depth of focus.

Fœdus virginum. (L.) Chlorosis.

Fœniculum vulgare. See **Fennel.**

Fœrster, Richard. A celebrated German ophthalmologist, inventor of the photometer (1857) and of the perimeter* (1868). Born Nov. 15, 1825, at Lissa, he studied medicine at Breslau, Heidelberg and Berlin, at the latter institution receiving his degree in 1849. In 1857 he settled in Breslau as ophthalmologist. In 1894 he became a life member of the Prussian House of Lords. July 31, 1899, he celebrated the jubilee, or 50th anniversary, of his doctorate in medicine, and formally retired from practice. He published: 1. *Ueber Hemeralopie.* (Breslau, 1857.) 2. *Ophthalmologische Beiträge.* (Berlin, 1862.) 3. Beziehungen der Allgemeinleiden zu den Erkrankungen des Sehorgans. (Graefe-Saemisch *Handbuch,* Bd. V, 1877.) 4. Künstliche Reifung des Cataracts. (*Archiv f. Augenheilk.,* 1883.) 5. Einfluss der Concavgläser auf die Weiterentwicklung der Myopie. (*Archiv f. Augenheilkunde;* Bd. XIV.)—(T. H. S.)

Fogging maneuver. FOGGING METHOD. In the "repression" treatment

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*A very brief history of our knowledge of the visual field may be thus stated: Hemianopia was mentioned by Hippocrates (fifth century B. C.). The first attempt to measure the field was made by Ptolemy (who flourished 150 B. C.). (The account of this has come down to us only *via* Damianus.) The blind spot was discovered by Mariotte, a Frenchman, in 1666. Scotomata were mentioned by Boerhaave in 1708. The first exact measurement of the visual field was made by the English physicist, Thomas Young, in 1801. Next, concentric contractions were described by Beer in 1817. The value of perimetry as a means of diagnosis was pointed out by von Graefe in 1856. Then came Förster with the first perimeter in 1868. This and the various later forms, or patterns, of the instrument are sufficiently pictured and described in the non-historical portions of this *Encyclopedia.* See, also, **Perimetry** and **Examination of the eye.**

of esophoria, the reduction of vision to about 20/70 by combining prisms (varying with the muscular imbalance), bases in and combined with a convex sphere, with which combination glasses the patient reads half an hour at night before retiring.

These terms are also used to indicate attempts to relax the accommodation prescribing an over-correction in hyperopia, the patient wearing the lenses for a longer or shorter period, preliminary to determining the static refraction.

Fridenberg (*Klin. Monatsbl. f. Augenh.*, Jan., 1908) advocates the "fogging method" (over-correction of hyperopia), in cases of persistent spasm of the ciliary muscle in which condition a certain degree of functional activity rather than complete immobility should be attained, and which is permitted by the method in question. When the spasm has been overcome a weaker glass, giving the best vision, may be substituted.

Foie. (F.) Liver.

Fold of transmission. Fornix conjunctivæ. Conjunctival cul-de-sac. Fornix (Gerlach). These terms are applied to the parts and the localities where the conjunctiva of the lid is reflected upon the eyeball—there to become the ocular conjunctiva. See **Cul-de-sac, Conjunctival**; as well as **Anatomy of the eye** and **Fornix conjunctivæ.**

Folds, Ciliary. The smaller of the plications of the ciliary processes. See **Histology of the eye.**

Folie. (F.) Insanity.

Folie choréique. (F.) Insanity in which there is incoherent delirium with maniacal excitement, and chorea. A second form, described by Maree, begins with hallucinations of sight, with extreme agitation, and an eventual condition simulating the delirium of fever.

Folklore of ophthalmology. Domestic ophthalmology. See **Popular ophthalmology**; as well as **Ophthalmology, History of.**

Follicles. Lymphocytes of the conjunctiva, as part of the adenoid layer, may or may not be normal. Certain it is that they are normal in the rabbit, cat, etc., but are not always readily demonstrated in man. They are always easily seen in most forms of conjunctivitis, especially in trachoma. See **Histology of the eye**; as well as page 3103, Vol. IV, of this *Encyclopedia.*

Follicles, Palpebral. The Meibomian glands.

Follicular conjunctivitis. A form of conjunctivitis in which the ordinary inflammatory catarrhal changes are accompanied by the development of round, pale-red, hemispherical structures, which project above the level of this membrane, and subsequently disappear with-

out leaving a trace behind. See page 3103, Vol. IV, of this *Encyclopedia;* as well as **Bacteriology of the eye.**

Follicular ophthalmia. See **Conjunctivitis, Follicular.**

Folliculi ciliares. *(L.)* A term sometimes used to designate the Meibomian ducts or glands in the eyelids.

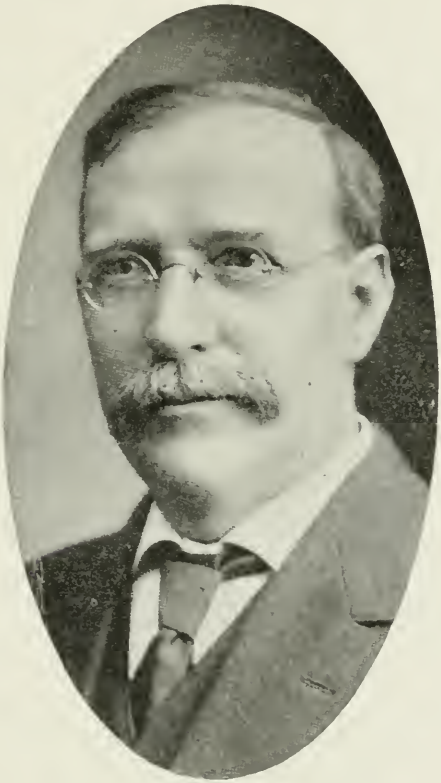
Folliculosis. Follicular catarrh. Simple granular conjunctivitis. Follicular ophthalmia. Follicular trachoma. This form of chronic catarrhal inflammation of the conjunctiva, best seen in children, has been variously described. See **Catarrh, Follicular.**

Follin, Francois Anthime Eugène. A well-known French pathologist, surgeon and ophthalmologist. Born at Harfleur, France, Nov. 25, 1823, he studied his profession at Paris, becoming in 1845 interne, in 1847 Aide d'Anatomie, in 1850 prosector to the faculty, and in 1853 surgeon to the Central Bureau. His degree was received in 1850, presenting as dissertation "Etudes sur les Corps de Wolf." In 1853 he was made extraordinary professor of surgery at the University. Up to this time he had written a number of books and articles dealing with anatomy, pathology and general surgery. Now, however, about 1853, he began to devote his attention more especially to ophthalmology, and became a celebrated operator on the eye. He wrote a large number of articles on this subject, dealing with glaucoma, its pathology and treatment, iridectomy, illumination, accommodation, retinal hemorrhage and the medical and surgical treatment of diseases of the lachrymal passages. His most important writing, from the point of view of ophthalmology, was that entitled *Leçons sur l'Application de l'Ophtalmoscope au Diagnostic des Maladies de l'Oeil* (Paris, 1859; Ger. Trans., Weimar, 1859). This atlas was the earliest work in the French language, devoted to the use of the ophthalmoscope. Follin died May 21, 1867, only 44 years of age.—(T. H. S.)

Foltz, Jean Charles Eugène. A French anatomist, physiologist and ophthalmologist. Born at Nancy, Jan. 28, 1822, he studied at the Strasburg Military School and at Val de Grâce. Settling in Lyons, he was appointed in 1854 assistant professor of anatomy and physiology, and, in 1865, full professor of the same subject, in the place of his uncle, Richard Foltz. He died Nov. 18, 1876. His ophthalmologic writings are: 1. Sur le Traitement Méchanique de la Myopie. (*Ann. de la Soc. de Méd. de Lyon*, 1859.) 2. Anatomie et Physiologie des Conduits Lacrymaux. (Ibid., 1862.)—(T. H. S.)

Foltz, Kent Oscanyan. A prominent eclectic ophthalmologist of Cincinnati, Ohio. He was born in Lafayette, Medina County, Ohio, Feb. 16, 1857, the son of Dr. William K. Foltz, who was one of the earliest and best known of eclectic physicians in the middle west.

Dr. Kent Oscanyan Foltz graduated from the Ashland, O., High School in 1872, and attended Buchtel College, at Akron, Ohio, for two or three years. For a time he worked at the retail, then at the wholesale drug business. Then he became an optician. At length, under his father's preceptorship, he began to study medicine. His medical degree was received at the Eclectic Medical Institute, Cincinnati, Ohio, in 1886. For a brief period he practised general medicine, but,



Kent Oscanyan Foltz.

in 1888 and 1889, at the New York Post-Graduate Medical School, he made a thorough study of the eye, ear, nose and throat. In 1890 he became connected with the Polyclinic, the Manhattan Eye and Ear Infirmary, and the Harlem Dispensary. Soon after, however, he gave up institutional practice, and engaged again in general work. In 1898 he removed to Cincinnati, having been appointed to the chair of Didactic and Clinical Ophthalmology, Otology, Rhinology and Laryngology in his alma mater—the Eclectic Medical Institute.

In 1891-92 he was President of the Ohio State Eclectic Medical Association. He was also one of the associate editors of the *Eclectic Medical Journal* for a number of years, during a part of which time he conducted the Eye, Ear, Nose and Throat Department of that publication.

He wrote: "*Manual of Eye Diseases*" (1900) and "*Manual of Diseases of the Nose, Throat, and Ear*" (1906). He also contributed numerous articles to Prof. Herbert T. Webster's "*Dynamical Therapeutics.*"

Dr. Foltz was about five feet eight inches high, and remarkably well built. He had red hair, a ruddy complexion and a sandy mustache. His eyes were a clear blue-gray. He was a great story-teller, and a most enjoyable companion. He was fond of music, art and literature, and had a large library, especially rich in works on criminology and psychology.

The only kind of books which Dr. Foltz would never read were those which related to religion. These he abhorred. In fact he was a most pronounced agnostic, never losing an opportunity to express his convictions on matters of religion as forcibly as possible.

He was a very kindly, although impetuous man, and many a struggling student and young practitioner had cause to bless the openhanded generosity of Dr. Foltz.

He died at Seton Hospital, Cincinnati, Ohio, June 6, 1908, shortly after an operation on the nasal passages.—(T. H. S.)

Foltz, Valves of. Valves (reduplication of the mucous membrane lining) of the lachrymal canals.

Fomentation. This term is generally accepted as meaning hot, wet, applications to an organ or part of the body, but is sometimes (perhaps erroneously) used to include cold applications similarly applied. On the whole, the most useful method of fomenting the eyes is the following, especially when employed in conjunction with collyria: The patient should lean well forward with the head over a basin full of hot (or cold) water, and, holding in each hand an end of a wash cloth or small towel (folded so as to measure 4x12 inches), lift or "scoop" the water repeatedly up to the tightly-closed eyes, forehead and temples for a period of three minutes. This is to be done as often as desired and to be followed by two or three drops of the eye water, put into each eye with the medicine dropper. When cold water is ordered it should be quite cold but never so cold as to make the hands, eyes or head ache. After using hot water the patient should not venture out for half an hour after its application. Neither hot nor cold water should be used for a longer time than prescribed.

Fond. (F.) Background (of the eye).

Fondant. (F.) Dissolvent.

Fondo dell 'occhio. (It.) Ocular fundus.

Fons lacrimarum. (L.) The inner canthus of the eye.

Fontana, Canal of. SPACES OF FONTANA. A series of passages or spaces (very small in man, but of great size in some of the lower animals) formed by the interlacing of the connective-tissue fibres forming the framework of the peripheral processes, or roots, of the iris; situated in the angle of the anterior chamber and serving as the medium of transudation of the aqueous humor from the interior to the exterior of the eye.—(Foster) See **Histology of the eye**; as well as **Anatomy of the eye.**

Fontana, Felice. A celebrated Italian physicist, chemist, and physiologist, whose name has been preserved for ophthalmologists in the expression, *canal of Fontana* (q. v.). Born at Pomarolo, near Rovereto, April 15, 1720, he studied at Padua, Bologna, and Rome. After a brief period spent as instructor in philosophy at Pisa, he was commissioned by the Duke of Tuscany to establish in Florence a natural history museum. He wrote "*Sui Moti dell' Iride*" (Lucca, 1765), and died March 9, 1805.—(T. H. S.)

Fontorbe's test. This is one of the numerous tests for simulated blindness, something after the style of the red and green glasses of the Snellen test (q. v.).

Foot, Jesse. An English ophthalmologist of the early 19th century, whose life-dates cannot be ascertained. He was physician to the Westminster Ophthalmic Hospital, London, and published a work entitled "*Ophthalmic Memoranda*" (London, 1838).—(T. H. S.)

Foot of a microscope. The part of a microscope by which it rests on the table.

Foot-screw. A form of adjusting-screw for leveling purposes.

Foramen. (L.) An opening, a perforation or pit.

Foramen centrale. A synonym of fovea centrales.

Foramen corneæ. If the sclera be regarded as a large segment of the spheroidal eyeball the space occupied by the cornea is known by several names, one of which is the foregoing.

Foramen lacerum orbitale. (L.) The sphenoidal fissure.

Foramen of Soemmering. A term applied to the appearance (sometimes depressed) presented by the retina at the yellow spot.

Foramen, Optic. The orifice of a short canal through the lesser wing of the sphenoid. Its diameter is about five millimetres transversely. It is often a little larger from above downward.

Foramen opticum sclerotica. A synonym of foramen corneæ.

Foramen orbitarium superius. (L.) Supraorbital foramen.

Foramen scleræ anterius. A synonym of corneal interval.

Forbes, C. F. An English military surgeon (life dates not obtainable) who wrote "*Observations on the History and Treatment of an Epidemic Ophthalmia, which appeared in the Fourth Battalion of the Royals, in Edinburgh Castle, during the months of July and August,* 1807."—(T. H. S.)

Forbes, Edward (1815-54), naturalist, born at Douglas, Isle of Man, entered the University of Edinburgh as a student of medicine; and in 1836 relinquished medical studies to devote himself to the natural sciences. In 1836-37 he studied at Paris under Geoffroy St. Hilaire, Jussieu, and De Blainville. In 1841 he joined the surveying ship Beacon as naturalist, and accompanied that vessel during the survey of a part of Asia Minor. On his return to England (1843) he became professor of botany in King's College, London, and curator of the Geological Society. In 1844 he was appointed paleontologist to the Museum of Geology; in 1851 professor of natural history in the School of Mines; in 1852 president of the Geological Society; and in 1853 he was elected to the chair of natural history in the University of Edinburgh. Forbes did much to advance and systematize special departments of natural history. His classification of the British starfishes opened a new era in that branch of zoology; and his discovery that air-breathing molluscs lived at the period of the Purbeck beds rectified many erroneous hypotheses. Among his separate works, may be instanced, as of interest to ophthalmologists: *Naked-eyed Medusæ* (1847).—*(Standard Encyclopedia.)*

Forbes, John. An English naval surgeon who wrote "Observations on Tropical Nyctalopia" (*Edinburgh Med. and Surg. Jour.*, 1811).—(T. H. S.)

Forbici. (It.) Forceps.

Forceps, Bull-dog. A small forceps with serrated edges for holding an artery; a *serre fine.*

Forceps, Capsule. The removal of a portion of the anterior capsule, as a preliminary to the extraction of cataract, depends for its success upon certain manipulations.

In performing the operation the patient is asked to look down and the eyeball is fixed below in the vertical meridian. The surgeon should have a clear view of the anterior capsule. The forceps are then introduced (closed) and the blades directed straight downwards. They are passed to the lower border of the pupil, and slowly opened to their fullest extent. The terminals are than pressed very carefully and slightly backward against the anterior surface of the lens and closed.

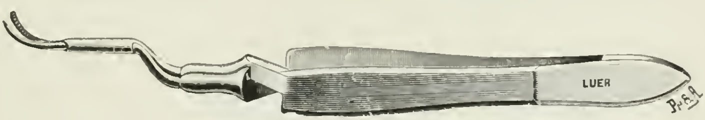
The forceps are then—always gently—pushed downwards. By this latter maneuver the capsule generally ruptures above. With a careful side-to-side movement the instrument, with the torn piece of capsule, is removed from the anterior chamber. If this maneuver has been properly performed the lens will come forward and the subsequent extraction is easy. Failure to seize the capsule in the first instance may be followed by a second trial. In soft, semi-fluid or swollen cataracts, especially if the capsule be tough, it is not easy to grasp the membrane. In attempting to tear out a piece of capsule in this way care should be exercised not to use force of any kind or in any direction lest the suspensory ligament be torn, the lens dislocated or some other injury be done to the ciliary body. If a reasonable attempt to use the capsule forceps fails a cystotome should be substituted, as repeated attempts to perform any step of a cataract operation is likely to demoralize the patient, while the efforts themselves may cause loss of vitreous or produce some other undesirable trauma. See **Cataract, Senile** and **Capsulectomy.**

Forceps, Fixing. See **Fixation instruments.**

Forceps-scissors. These instruments are cutting scissors with forceps-like handles. See **Forceps, Ophthalmic.**

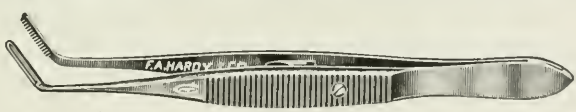
Forcipula claudibilis. (Obs.) Small forceps with a catch.

Forceps, Ophthalmic. Forceps in general. The number of instruments of the forceps type employed in ophthalmic surgery is very



Abadie's Capsule Forceps.

large. Descriptions of many will be found scattered throughout the pages of this *Encyclopedia*, and the reader is referred for further information regarding their uses and forms to such headings as **Fixation instruments**; **Cataract, Senile**; **Entropion**; **Chalazion**; **Ptosis**;

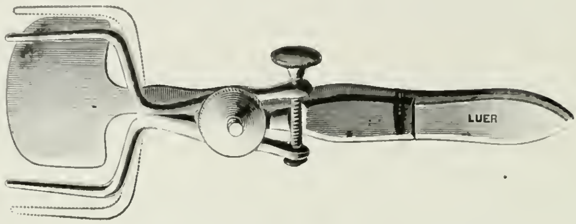


Allport-Prince Advancement Forceps.

Expression; **Cilia, Misplaced**; **Instruments, Ophthalmic**; **Blepharoplasty**; **Trachoma**; **Canthoplasty**, and generally speaking, to captions of the name of the operator, inventor or dealer with whom the instrument in question is mostly associated. In the following sub-

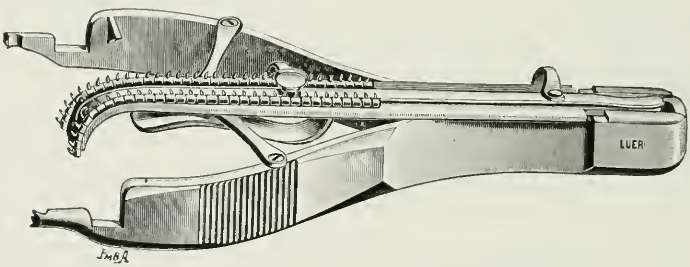
headings the last-named (alphabetical) order is followed as nearly as possible.

No description of a particular forceps is given where a cut obviously furnishes the required information.



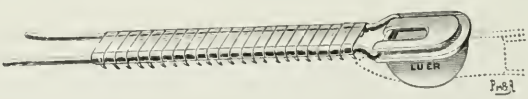
Aubaret's Forceps for Lid Operations.

So far as *fixation forceps* is concerned they constitute a (large) class which is best included under the caption **Fixation instruments**, to which the reader is referred.



Automatic Forceps for Putting in Metal Sutures.

The Allport-Prince advancement forceps is arranged so that the teeth of the male blade fit into a narrow fenestrum in the opposing blade—with the purpose of a firmer grasp on the tendon than is secured by some other instruments of the kind.

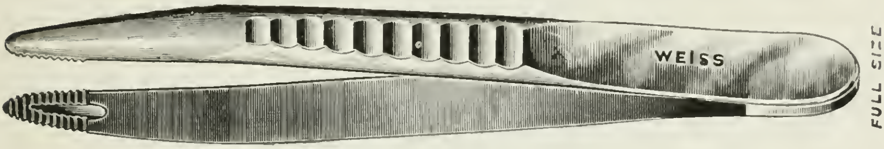


Forceps-magazine for Holding the Metal Sutures.

Automatic forceps for placing metal sutures are not much used by the ophthalmic surgeon, but they will be found valuable in the more extensive forms of lid surgery, in certain operations on the orbit, Krönlein's procedure for instance, and by those ophthalmologists who operate on brain structures.

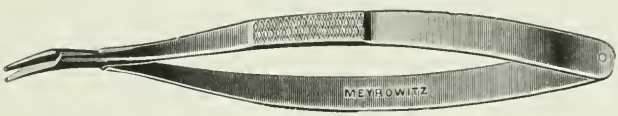
Barraquer's *forceps-cystitome* is intended to remove a considerable portion of the anterior capsule as a part of the extraction of cataract.

The *lid forceps* of Bettremieux is intended to enable the operator to evert the eyelid and expose the fornix. It is recommended for use in ophthalmia of the new-born to permit of thorough cleansing and treat-

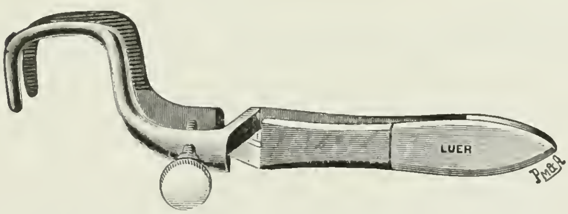


Bader's Epilation Forceps.

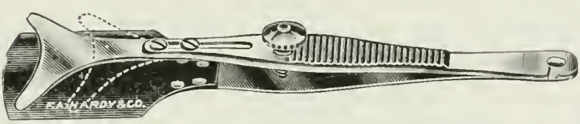
Barraquer's Forceps-Cystitome.



Beaupré's Cilia Forceps.



Forceps and Clamp of Bettremieux for Complete Eversion of the Lid.



Nelson Black's Self-retaining Lid Plate, for Operating on the Eyelids.

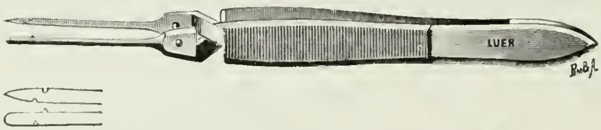
ment of the lining of the conjunctival cul-de-sac, in which case it is to be employed only by the (very cautious) surgeon himself. It is made in two sizes.

The *cystectomy (capsule) forceps* of Bourgeois is introduced in the usual manner (See **Forceps, Capsule**) but when the anterior

capsule is grasped and the branches of the forceps are closed the removal of the included anterior capsule is accomplished by gentle torsion and not by tearing away the membrane from the lens.

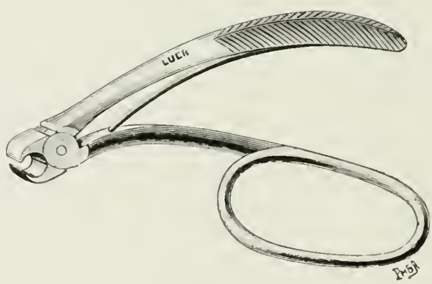
Bourgeois' *forceps for the performance of blepharorrhaphy.* It is

The Capsule or Cystectomy Forceps of Bourgeois.



Capsulutomy Forceps of A. Bourgeois.

often a difficult matter to freshen the internal border of the palpebral margin because of scar tissue, due to injuries or disease, in many forms of blepharoplasty. These cutting pincers readily pierce the densest tissue and are recommended for the purpose indicated. They cut out



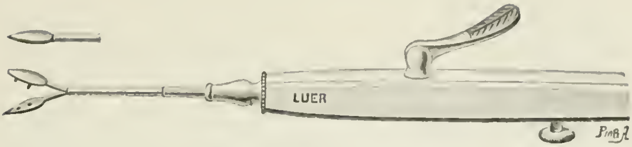
Cutting Forceps for Blepharorrhaphy. (Bourgeois.)

Bruch's Forceps for Everting the Eyelid.

a piece of tissue one cm. long, after which the operation may be completed by scissors, or in the usual way.

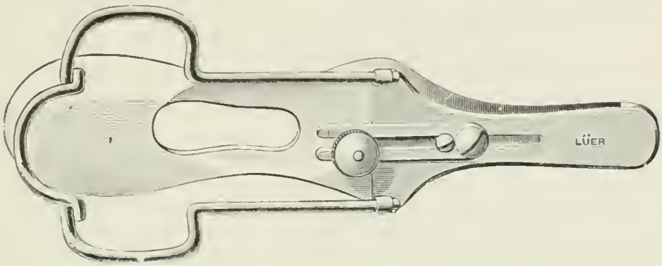
The *needle forceps* of Cantonnet is employed for removal of capsular membranes remaining after cataract extraction.

Chibret's *lid forceps* is intended to evert the lids and freely expose

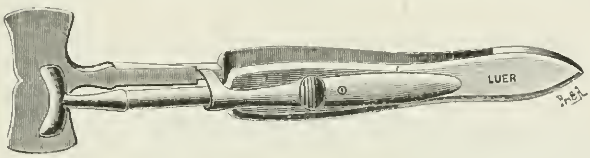


Cautonnet's Forceps-Needle.

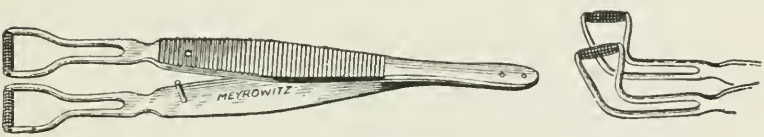
Chaker Bey's Forceps for Complete Eversion of the Lids.



Charamis' Forceps and Lid-plate for Operations on Trichiasis and Entropion.

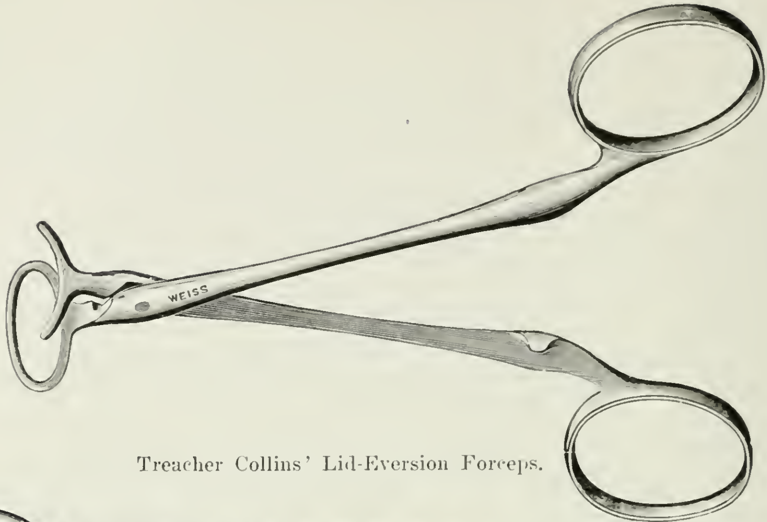


Chibret's Forceps for Everting the Lid and Exposing the Cul-de-sac.

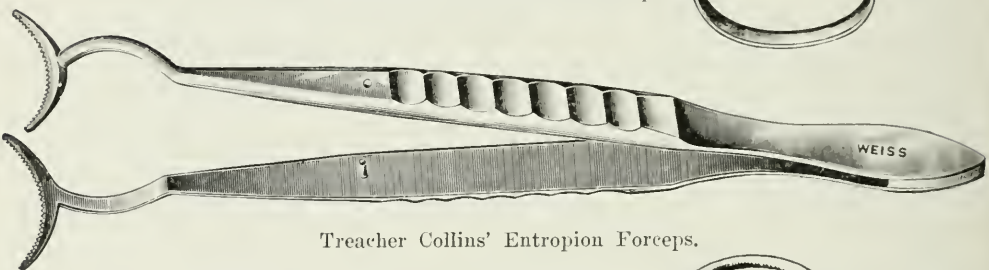


Claiborne's Roller Forceps for Expression of the Granular Tissue in Trachoma.

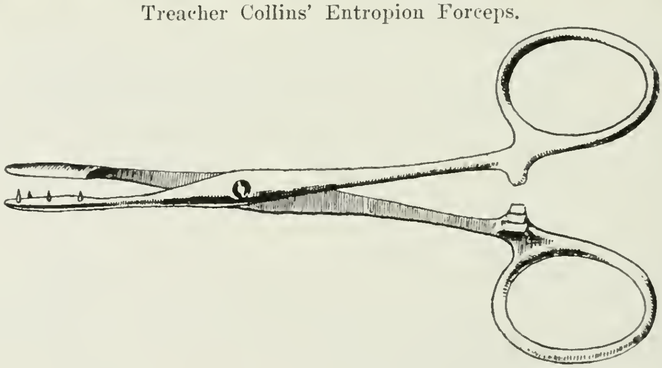
Chibret's Enucleation or Luxation Forceps.



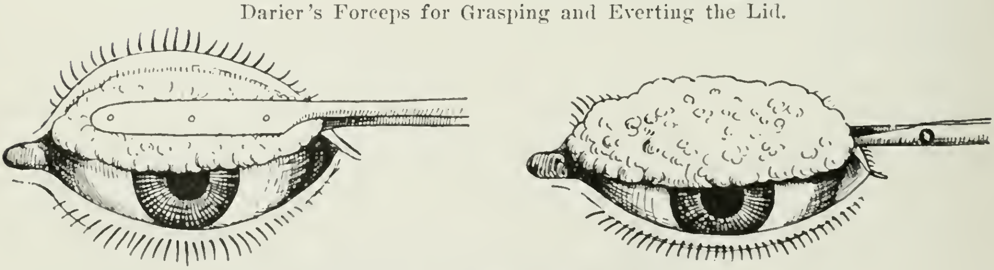
Treacher Collins' Lid-Eversion Forceps.



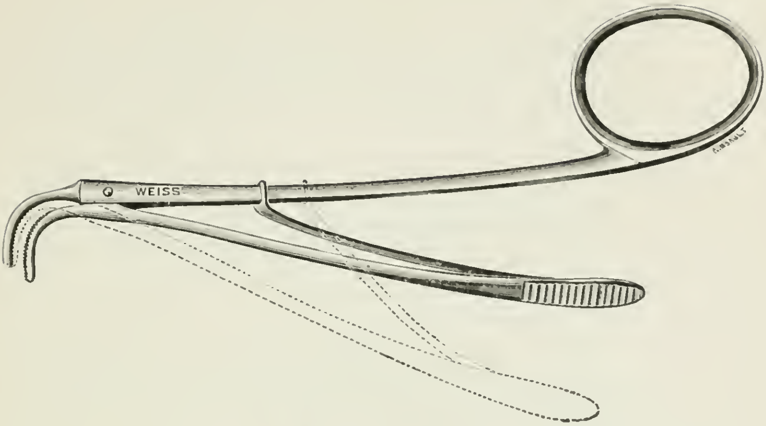
Treacher Collins' Entropion Forceps.



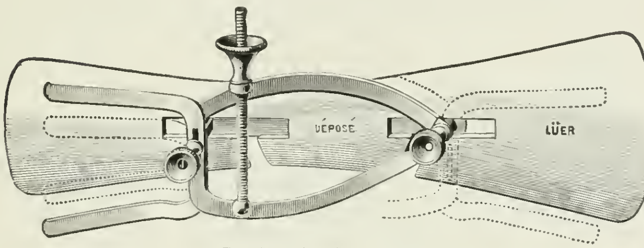
Darier's Forceps for Grasping and Everting the Lid.



Illustrating the Use of Darier's Forceps.

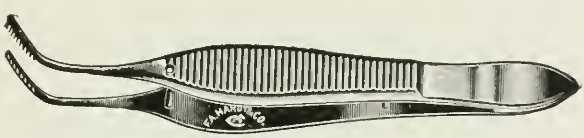


Deschamps' Strabismus or Advancement Forceps.



Didikas' Lid Forceps.

Donberg's Forceps for Expression of Granulation Tissue.

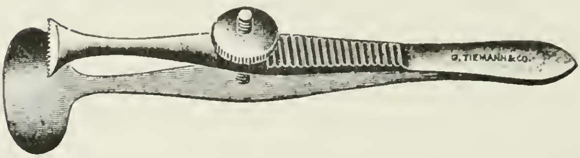


Donberg's Capsule Forceps for Cataract Operations.

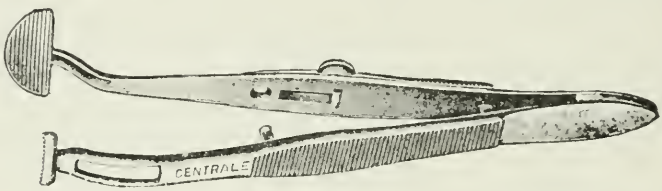
Dowel's Forceps-Cystitome, with Teeth on the Convexity of the Blades.

Lid Forceps of Duboys-Lavigerie.

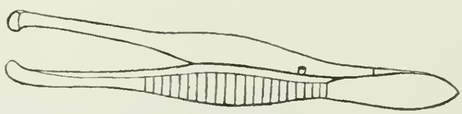
Duckworth's Cilia (Epilation) Forceps.



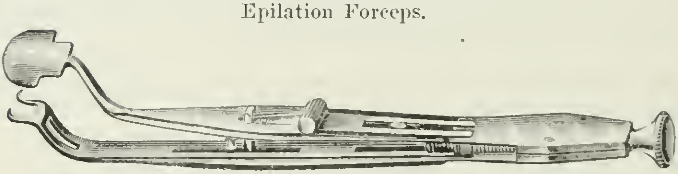
Ehrhardt's Clamp Forceps for Controlling the Lids during Operation.



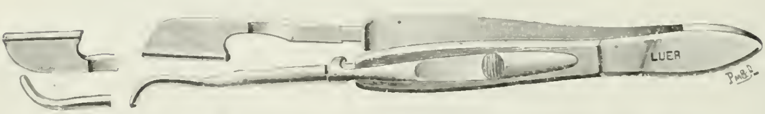
Eisenstein's Forceps for Fixing and Everting the Lids.



Epilation Forceps.



Falta's Forceps and Clamp for Lid Operations.

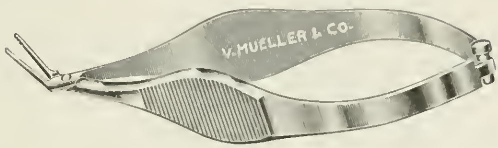


Figarola's Forceps for Complete Eversion of the Eyelid.

(Collin's) Fisher's Iridectomy Forceps.

the cul-de-sac, especially for operative purposes. Its *modus operandi* is sufficiently indicated by the figure in the text.

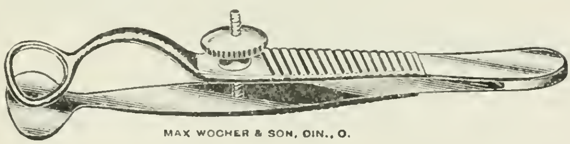
In Didikas' *lid-plate forceps* for operations on the eyelids the forceps may be placed on either the wide or narrow plate, and the pressure is regulated by screws.



Francis' Capsule Forceps.

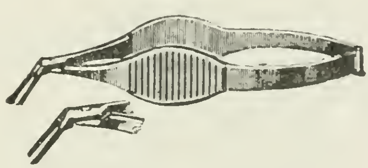
Eisenstein's *forceps for everting the lid.* For operations on the lids this device will be found useful though the body and blades are often made too heavy and cumbersome.

Francis (*Practical Med. Series,* 1910) claims for the *iris forceps*



Francis's Chalazion Forceps.

that appear in the accompanying figure the following advantages: 1. While sufficiently strong to be stable, its small size and light weight makes manipulation easier than with a larger and less delicate instrument. 2. The teeth are placed in the rear and are smoothed down so



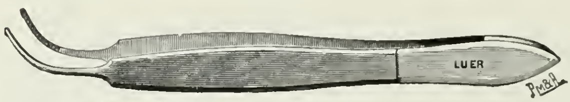
Francis's Iris Forceps.

that when the blades are closed no uneven surface is presented to engage in the wound or prematurely entangle the iris. 3. A firm and steady hold is permitted on account of the wide grasp for finger and thumb. 4. The blades open readily so that control is easy. 5. The instrument, being made with an aseptic lock and a threaded pin, is readily taken apart for cleaning. 6. On account of the crossed blades

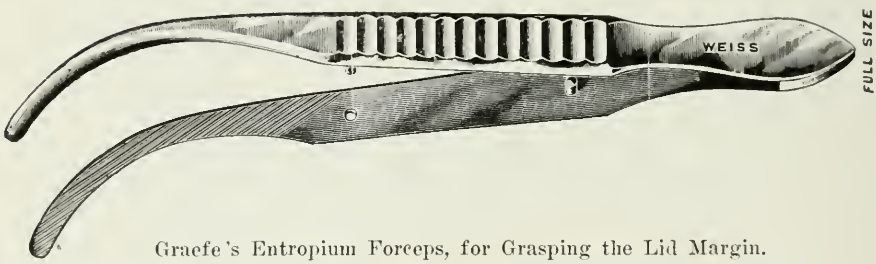
the forceps may be introduced through a very small corneal incision.

Harry Gradle has devised an S-shaped bend in the shank of his *iris forceps*, just above the tooth area, so that the end of the instrument can easily slide over the iris and engage the anterior capsule while the iris proper is well below the shank, and in no danger of being entangled.

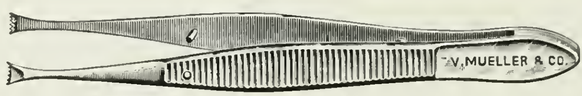
Galezowski's (Trachoma) Granulation Forceps.



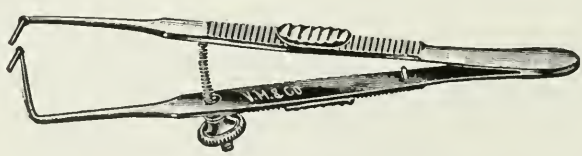
Graefe's Capsule Forceps.



Graefe's Entropium Forceps, for Grasping the Lid Margin.

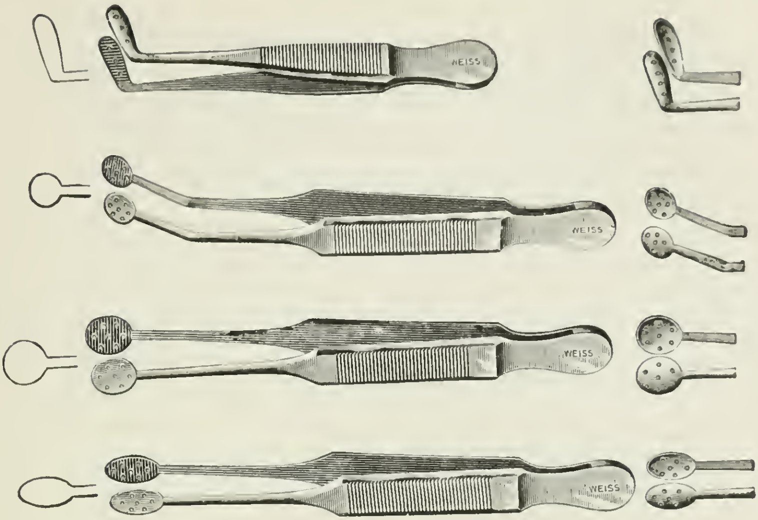


Graefe's Fixation Forceps without Catch.

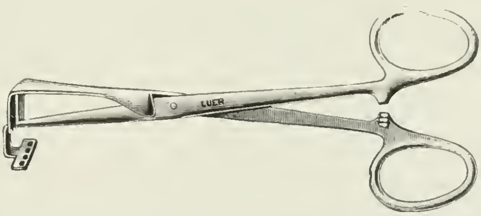


Greene's Tendon Tucking Forceps.

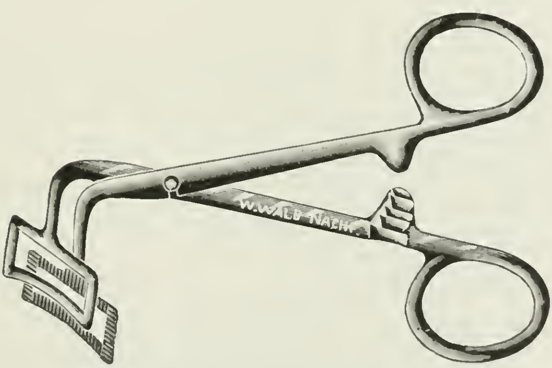
Holth's *vitreous forceps* are variously used for the extraction of foreign bodies from the vitreous; (380) for use near the meridional incision; (381) for use behind the lens and the ciliary body; (382, 382a) for use in the posterior two-thirds of the vitreous, with circular or oval blades. They are made with plane blades, transversally ridged, or with blades slightly concave on the inside and smooth. See **Injuries of the eye.**



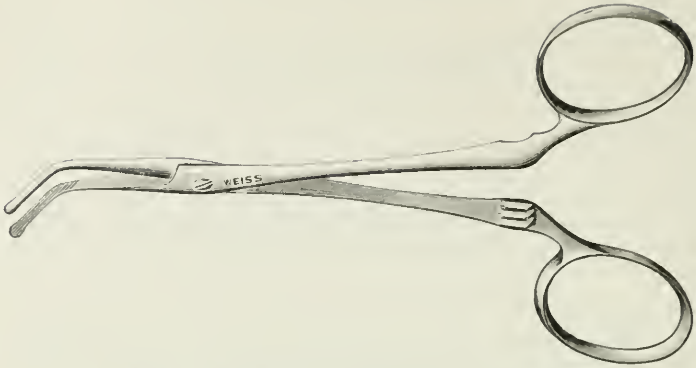
Holth's Forceps for the Extraction of Foreign Bodies from Various Parts of the Vitreous Body.



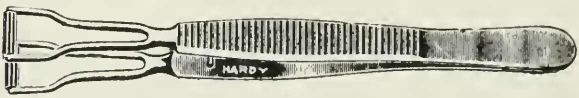
Houzel's Forceps for Grasping and Fastening Compresses.



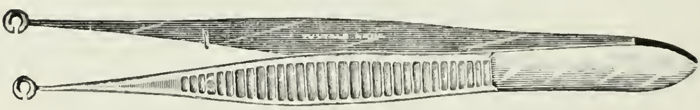
Israelson's Forceps for Transplanting Mucous Grafts from the Lip in Trichiasis and Entropion.



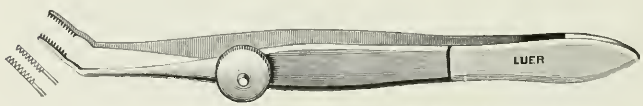
Jewell's Strabismus (Advancement) Forceps.



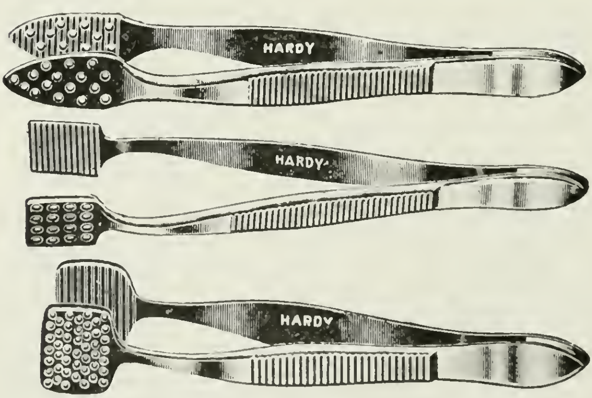
Knapp's Trachoma-Expression or Roller Forceps.



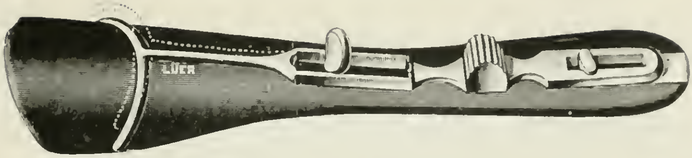
Kuhnt's Forceps for Placing Corneal Sutures.



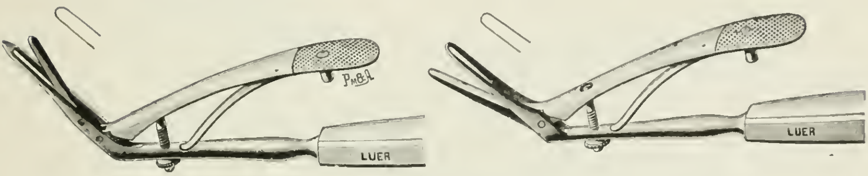
Kuhnt's Forceps-Cystitome, with Automatic Stop.



Kuhnt's Expression (Trachoma) Forceps.

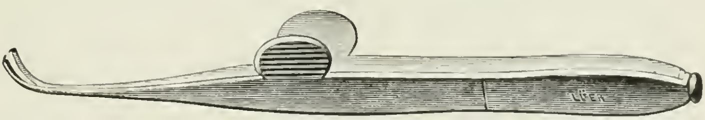


Landolt's Lid Forceps with Hard Rubber Plate.

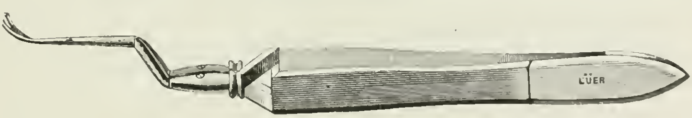


Lapersonne's Punch-Forceps for Cutting a Piece out of Post-operative Capsular Membranes.

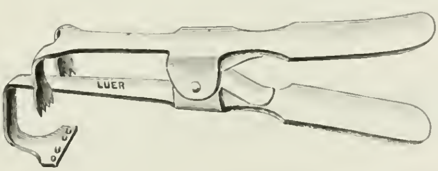
Levinsohn's Scissors-forceps for Making an Opening in Thickened Capsular Membranes.



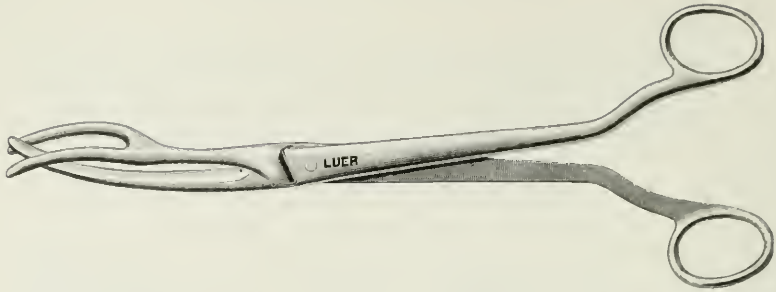
Liebreich's Forceps-Cystitome, Provided with Teeth on the Convex Surface of the Terminals.



Luer's Iris Forceps, with Triple Articulation.

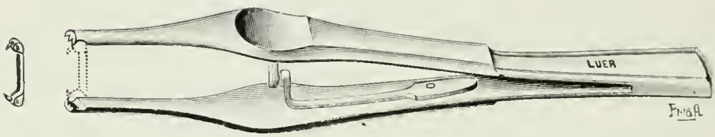


Forceps, with Spring, for Fastening Compresses.

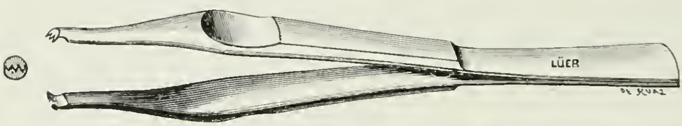


Luer's Fork-Forceps for Removing Instruments from Boiling Water.

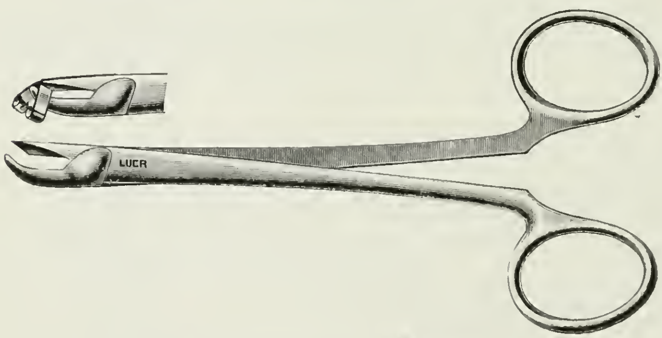
Metal Sutures, for Use with Forceps.



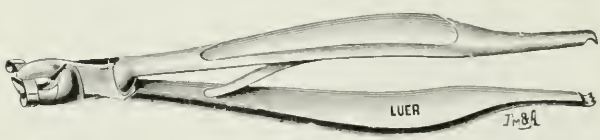
Luer's Forceps, with Spring, for Putting in Metal Sutures.



Luer's Simple Forceps for Putting in Metal Sutures.

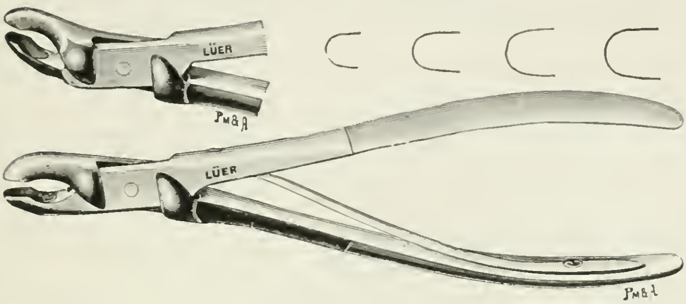


Forceps for Taking out Metal Sutures.

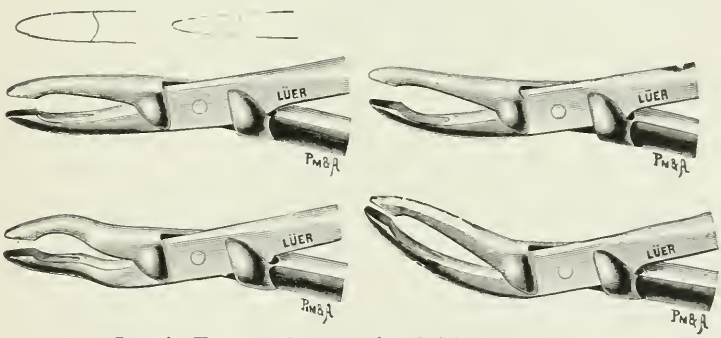


Luer's Forceps for Both Putting in and Taking out Metal Sutures.

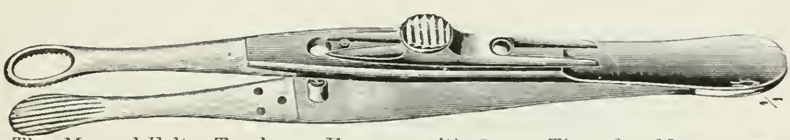
Luer's Triple Articulation Forceps-Cystitome, with Teeth on the Convexity of the Terminals.



Luer's Forceps Gouge.

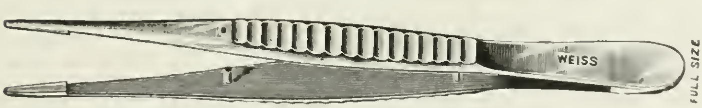


Luer's Forceps Gouge, of Additional Patterns.

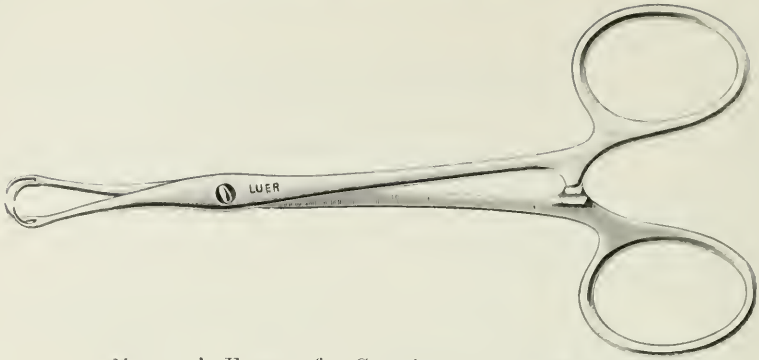


The Marczel-Falta Trachoma Forceps, with Ivory Tips, for Massage with Sublimate Solution.

Motais' Cystectomy Forceps.

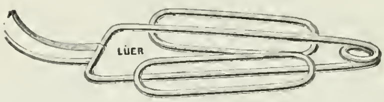


Mules' Forceps for the Removal of Sutures.

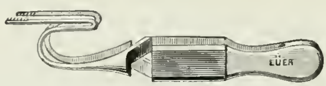


Musseux's Forceps for Grasping the Lachrymal Sac.

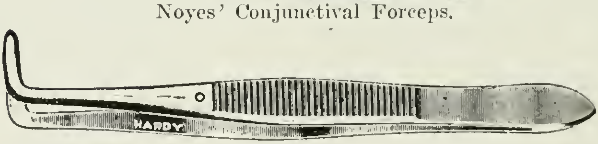
Nicati's Iris Forceps.



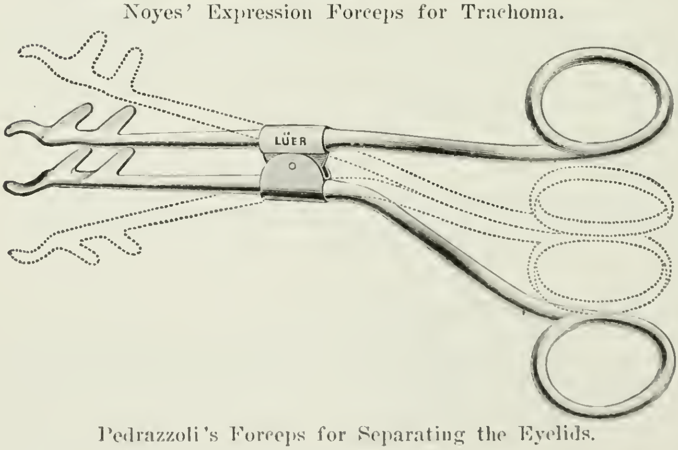
Nicati's Wire Forceps-Cystitome, with Teeth on the Convex Surface of the Terminals.



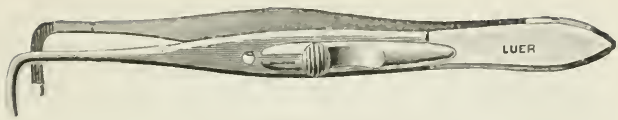
Noyes' Conjunctival Forceps.



Noyes' Expression Forceps for Trachoma.

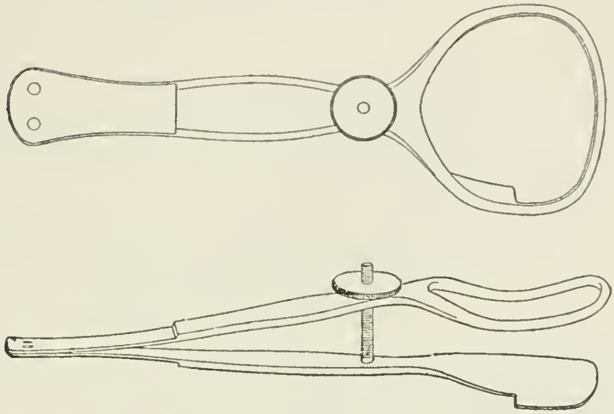


Pedrazzoli's Forceps for Separating the Eyelids.

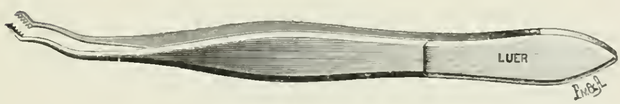


Pflugk's Grooved Forceps for Oculomuscular Advancement.

This instrument is locked by means of a secure bolt and catch, and may be used on either the right or left side.

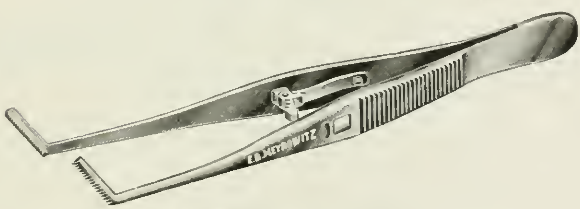


Piccaluga's Modification of Desmarres' Lid Forceps.

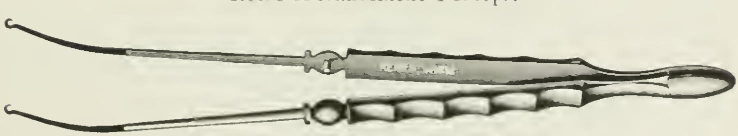


Pley's Anterior Capsule Forceps.

Prince's Trachoma (Expression) Forceps.

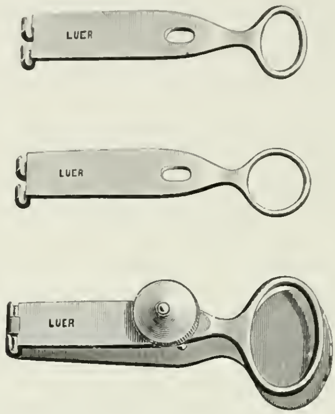


Reese Advancement Forceps.

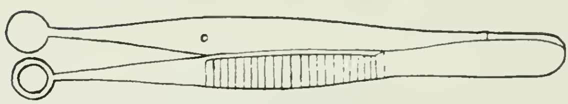


Reisinger's Hook Forceps, for the Extraction of the Nucleus in Certain Forms of Hard Cataract.

Reisinger's Iris Forceps in Cataract Extraction.

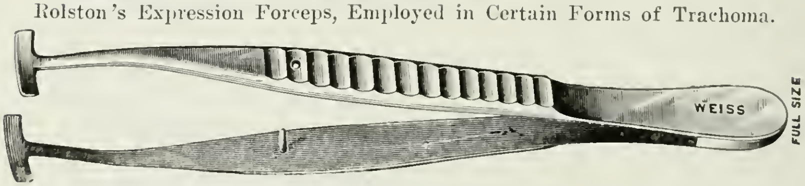


Reiss' Chalazion and Lid Forceps.

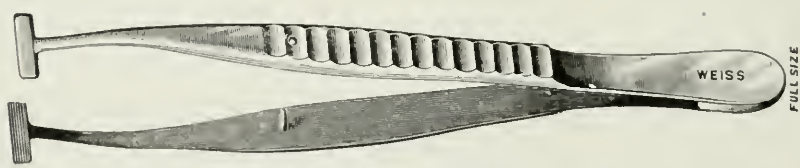


Ring Forceps.

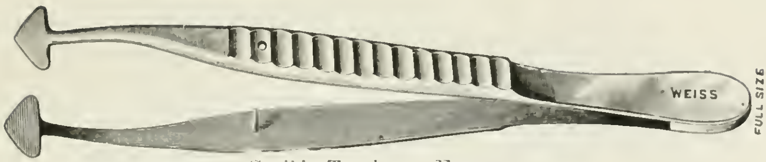
Rolston's Expression Forceps, Employed in Certain Forms of Trachoma.



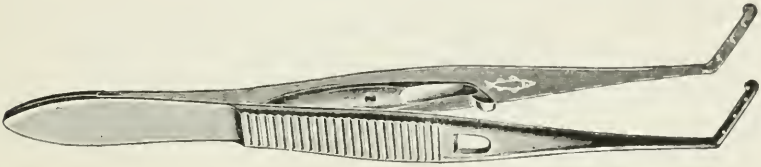
Saril's Trachoma Forceps.
Curved blades; to be adapted (in expression of granulations) to the margins of the upper lids.

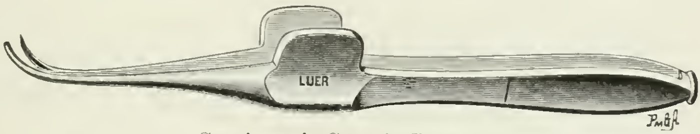


Saril's Trachoma Forceps.
Flat blades, for use on the lower lids.



Saril's Trachoma Forceps.
Triangular blades intended to squeeze out granulations from all conjunctival areas.

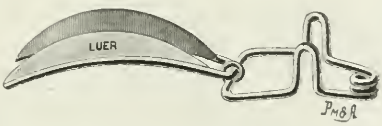

Sattler's Advancement Forceps.
Three points on the male blade fit into openings on the second branch, and securely hold the tendon or muscle.



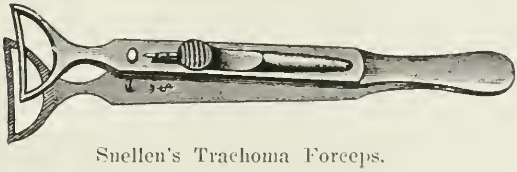
Saurineau's Capsule Forceps.

Schmidt's Spoon Forceps, for the Extraction of Lenticular Remains.

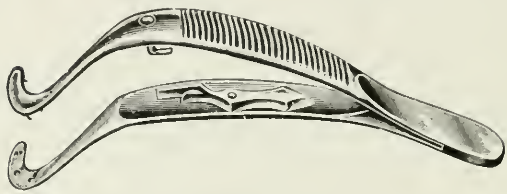
Sichel's Forceps for Making an Artificial Pupil.



Sichel's Forceps for the Relief of Ptosis.


Snellen's Trachoma Forceps.

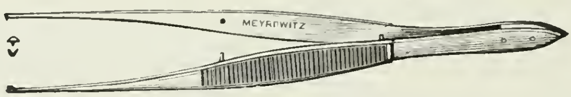
Soderlinh's Forceps for Canthoplasty.



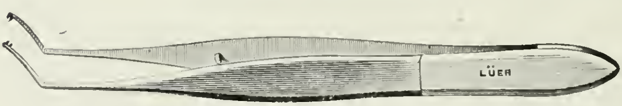
Stevenson's Advancement Forceps.

The handles are bent to follow the outline of orbital margins (so that the instrument is applied to the face) while three needle points pierce and keep firmly in place the oculomuscular tissues.

Straight Cilia (Epilation) Forceps.

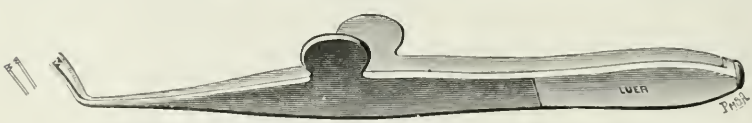


Straight Iris Forceps.



Terson's Forceps-Cystitome, or Anterior Capsule (Cataract) Forceps.

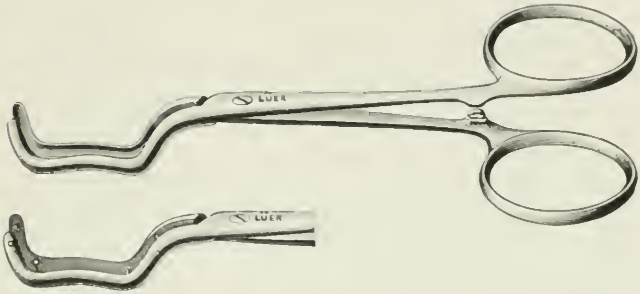
There are three forms of this instrument—according to the number of teeth in each blade—2 and 2, 4 and 4, 5 and 5.



Terson's Forceps-Cystitome, with Special Handle.

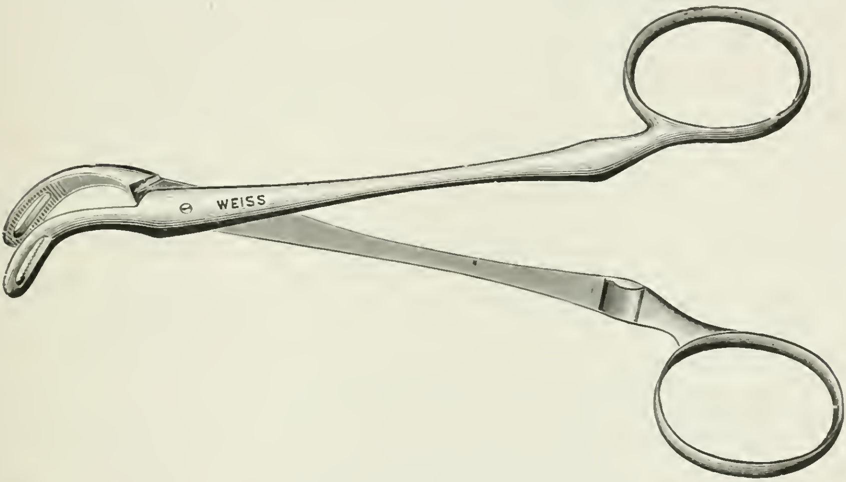
Two forms are generally used; one with 2 and 2 teeth, another with 4 and 4 teeth.

Terson's Three and Five-toothed Anterior Capsule Forceps.

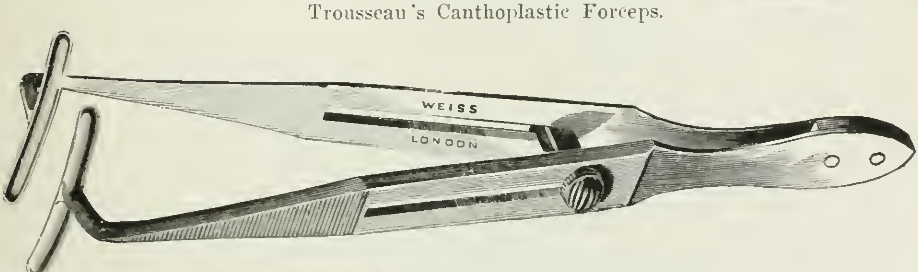


Thiebaut's Forceps for Complete Eversion of the Eyelids.

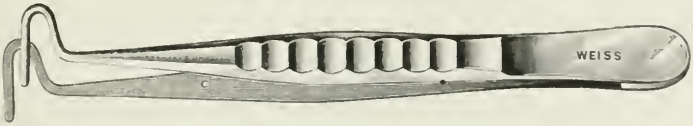
The instrument is provided with needle-points for the more effective fixation of the lids.



Trousseau's Canthoplastic Forceps.

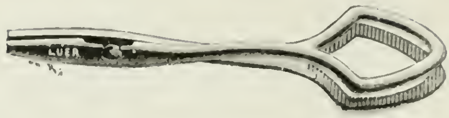


T-Shaped Entropion Forceps.

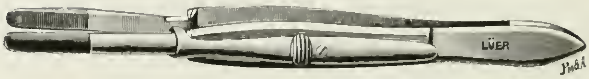


Tyrrell's Trachoma Forceps.

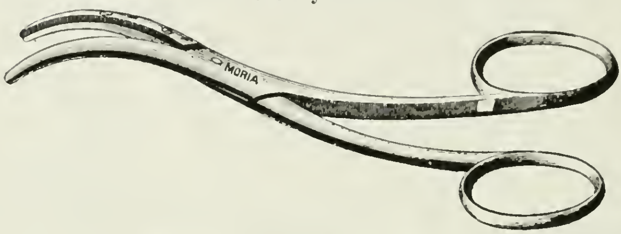
This instrument is intended to reach and squeeze, in particular, otherwise inaccessible granulations at the ocular canthi.



Valude's Orbital Ring Forceps.

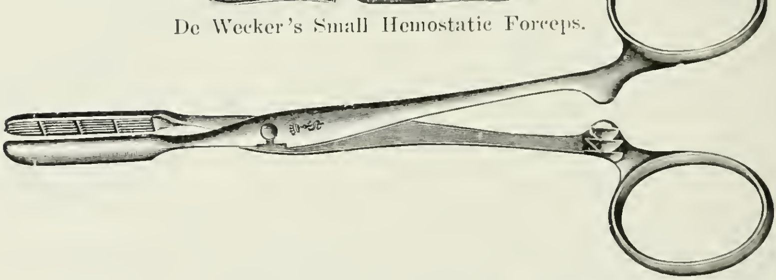


De Wecker's Forceps with Caoutchouc Terminals and Sliding Catch for Everting the Eyelids.

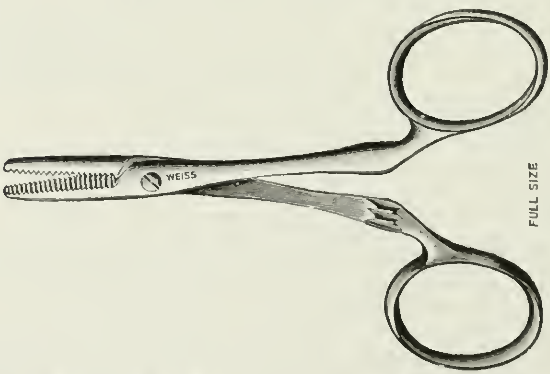


De Wecker's Larger Hemostatic Forceps.

De Wecker's Small Hemostatic Forceps.

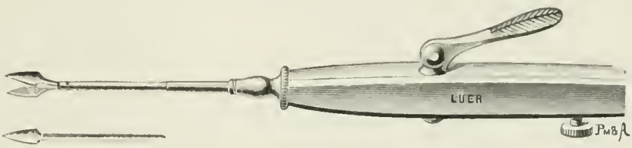


Weeks' Grattage Trachoma Forceps.

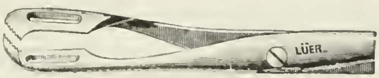


Spencer Wells' Miniature Artery Forceps, Useful in Ophthalmic Operations.

Luer's *metal-suture forceps* are sold in at least two patterns; one is employed for both inserting and removing the sutures, and another (see the figures) for placing them *in situ*. Still another model (see the cut) is useful for both purposes.



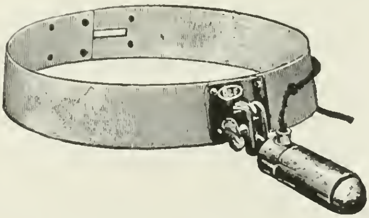
Wilde's Capsule Forceps and Scissors.



Ring (Chalazion, etc.) Forceps of Yacorides.

The *forceps gouge* of Luer, mainly employed for operations in and about the orbit, are made of several sizes and shapes, and with the jaws set at various angles with the handles.

Forehead lamp. Numerous devices, most of them electrically arranged, are elsewhere depicted in this *Encyclopedia* for illuminating the external eye. See, among other headings, **Examination of the eye.**



Electric Forehead Lamp, for Examining the Exterior Eye.

Foreest, Pieter van. This remarkable man is known as the "Batavian Hippocrates." He is also often referred to by his Latin name, Petrus Forestus. Born in Holland in 1522, he received his medical degree at Bologna, and afterwards studied for a long time at Rome, Padua, and Paris. He practised for a time at Bordeaux, then at Pluviers, but settled at length in Alkmaar, Holland, which seems to have been his native town. Here he practised for twelve years, and then removed to Delft. At the founding of the Leyden University he was made (of course, the first) professor of internal medicine at that institution. He devoted considerable attention to diseases of the eye, and was one of the first physicians to prescribe concave lenses for myopia. He

seems, however, not to have performed the cataract operation. After forty years of both medical and surgical activity at Delft, he returned to Alkmaar, where he died in 1597, aged 75.

His most important works, both of which contain ophthalmic observations of some importance in their day, are:

1. *Observationum et Curationum Medicinalium Libri xxxii* (Leyden, 1587-1610).

2. *Observationum et Curationum Chirurgicorum, Libri xi.*—(T. H. S.)

Foreign bodies in the eye. This extensive and important subject will be fully treated under the heading **Injuries of the eye.** It has already had some attention in the section devoted to **Electromagnet,** where the detection and removal of certain intraocular foreign bodies are discussed and illustrated: also under such captions as **Cornea, Foreign bodies in the,** not to mention **Sympathetic ophthalmia,** this heading will, in addition, be studied.

Here, it may be allowable to add a few paragraphs from the *Ophthalmic Year-Book* dealing with recent improvements in methods for localizing intraocular foreign bodies and the means of removing them. To this is appended some observations on *foreign bodies in the orbit.*

The eyeball being invisible in the skiagraph, and thus rendering it difficult to determine whether a foreign body is in the eyeball or orbit, Wessely (*Arch. für Augenh.*, page 161, 1912, and *Ophthalmology,* viii, p. 247, 1912) recommends placing a thin glass shell in the conjunctival sac. The part corresponding to the cornea contains a high percentage of lead so that this shows as a darker shadow in the skiagram, and thus facilitates fixing the situation of the foreign body. Holth (*Ophthalmoscope*, vol. ix, p. 550, 1912) sutures a pair of lead buttons at the upper and lower margins of the cornea. These give shadows which have a definite relation to the eyeball, no matter what position the latter may assume when the skiagraph is taken.

Gifford (*Ophth. Rec.*, xxi, p. 8, 1912) has for eight or ten years tucked small bits of brass or silver wire into a conjunctival pocket at the upper and lower corneal margins, with a very satisfactory result. He observes that the great advantage of fixed limbus localizers as opposed to those methods in which the localizers are outside of the eye, or even on the outside of the lids, is the possible movement of the eyeball after closure of the circuit; under these circumstances the latter class of localizers would give an erroneous idea of the position of the foreign body, which would not happen with the limbus local-

izers. Mick (*West. Med. Rev.*, Aug., 1911) also has described this method.

Alt (*Amer. Jour. Ophth.*, xxiii, p. 328, 1912) reports a case of infection following a perforating wound with no history and which was treated by insufflation of xeroform. A skiagram showed a number of rather strangely placed foreign bodies within the eye; these shadows were in all probability caused by the bismuth contained in the xeroform powder. The iridocyclitis recovered though leaving the eye blind; there have never been any symptoms of irritation of the other eye. A case like this throws some light upon those instances in which eyes were removed for the supposed presence of foreign bodies as shown upon the plate but which could not be found in the enucleated eyeball.

Arcelin (*Rev. Gén. d'Opht.*, xxxi, p. 241, 1912) points out that to estimate the size of a foreign body by radiography one must have a sharp print and know the divergence of the rays and the angle that the foreign body makes with the plate. He says the radiographer should never state that no foreign body was present, and gives a case in which such a statement was proven erroneous.

Randolph (*Ophth. Rec.*, xx, p. 113, 1912) reports two cases in which the x-rays failed to locate foreign bodies which were afterwards found in the enucleated eyes. Both were steel. The first had been carried in the eye for nineteen years with resultant blindness. A recent injury set up recurrent attacks of inflammation for which the eye was enucleated. The piece protruded from the eyeball behind, well out into the orbit, and about half an inch to the nasal side of the optic nerve. It was a little thicker in one part, and the extra-ocular part was enmeshed in a tough capsule. Three-fourths of it lay without the eye while the inner end was sticking through the retina. But for the recent injury the man would doubtless have carried the sliver of steel the rest of his life. In the second case the day after the injury there was a perforation at the limbus and a probable minute slit in the iris. The media were cloudy, so that the fundus details were not discernible. A foreign body was strongly suspected but three plates were negative, the first taken at once, the other two at the end of a month. As the eye continued to grow worse it was enucleated, and far back in the vitreous surrounded by a mass of exudate was an irregularly-shaped bit of steel.

In Allport's (*Ophth. Rec.*, xxi, p. 65, 1912) case a piece of steel was found after enucleation, in a small mass of exudate attached to the eyeball, having passed completely through the globe. The x-rays showed that the foreign body moved with the eyeball; it could not be

detected or removed by the magnet. Jung (*Deutsche Med. Woch.*, Oct. 5, 1911) calls attention to the impossibility of positively recognizing the presence of a foreign body, as in the eye and not in the orbit, in every case, by any known method. Where the shadow remains sharply-defined and single upon movements of the eyeball, the foreign body is naturally extra-ocular. Kohler's assumption, that doubling of the shadow upon movements of the eye is a positive indication of the presence of a foreign body within the same, has been found not to hold good in every case.

When the sideroscope has but a single magnetic needle the instrument must be placed in the magnetic meridian. To avoid this necessity an astatic system has been employed. As the lower needle was immovable the system was only partially astatic. If the astatic needles are arranged close together in a single tube the two needles mutually interfere in their action upon the bit of iron so that they are less sensitive than the single needle. Spuler (*Klin. M. f. Augenh.*, Oct., 1911) has united the astatic needles so that they may swing together in the same plane, each in its own tube. The distance between the two needles, being about 12 cm., is of no importance as regards the influence of terrestrial magnetism, but as regards the effect upon the bit of iron such disturbing influence is excluded by the second needle. To abolish the influence of electric currents and large accumulations of iron, as also to vary the zero point and to make the needles as sensitive as possible, two revolving magnets are attached to the bottom plate. These magnets can be revolved in opposite directions about a vertical axis. Each magnet moreover is movable by itself. The reflecting mirror is obtained from the surface of a weak convex lens (0.5 D.) silvered on one side, set in a cell in the center of the frame between the magnets. A sharp image of an illuminated thread or slit is thrown upon the scale at a fixed distance by the reflecting surface of the lens.

In Gallemaert's (*Arch. d'Opht.*, xxxi, p. 497, 1912) magnetometer the signal magnet is replaced by three superimposed magnets with their poles in the same direction. Two independent magnets are so disposed as to facilitate the regulating of the indicator magnet; a mirror, telescope and graduated rule complete the apparatus. The inventor claims extreme sensibility for his apparatus permitting ready recognition of bits of iron weighing less than a milligram.

Haab (*Arch. f. Augenh.*, lxix, p. 111, 1912. *Ophthalmoscope*, x, p. 652, 1912. *Ophthalmology*, viii, p. 26, 1912) considers localization of the foreign body by the x-rays and sideroscope as useless, since the magnet seeks the body wherever it is. Extraction is to be practised through the anterior chamber whenever possible, to obviate the danger

of subsequent detachment of the retina from the scleral incision. The magnet can never be too powerful; its action can be weakened by keeping it at a distance from the eye and using a longer point. Care must be taken that the foreign body does not become imbedded during extraction in the posterior surface of the iris. The patient should be operated upon sitting so that he can easily draw his head back and the current should be closed and opened by the foot.

Weill (*Am. Jour. Ophth.*, xxix, p. 129, 1912) advocates the corneal route without scleral incision for the extraction of magnetic bodies with the fixed giant magnet. The magnet cannot be too strong, but the technique of its application must be well understood, as irreparable damage can be quickly wrought by its faulty use. Before the attempt at extraction is made cocain with perhaps adrenalin is instilled, the skin about the eye made as sterile as possible, as also the magnet tip and adjoining parts, and the conjunctival sac irrigated with a suitable bland sterile solution. The pupil must usually be dilated. A sterile rubber fitting that portion of the magnet adjoining the tip is to be recommended. A cap of sterile material is to be placed over the patient's hair and a mask is advisable. Examination with the x-rays he considers unnecessary, as costing valuable time and adding to the danger of infection. The same magnet is useful in the removal of steel needles, pins, tacks, etc., from other accessible parts of the body; the application should not be discontinued too soon. This paper very properly insists upon the necessity of proper knowledge upon the part of the operator who proposes to use the magnet. Haab himself has given minute directions and has sought to show that the poor results obtained by some operators were due in large part to its unskillful use.

Although a partisan of the giant magnet, Nance (*Jour. Ophth. and Oto-Laryngol.*, vi, p. 325, 1912) thinks it is better, wherever possible, for the surgeon to know what he is doing, rather than to guess. His experience has taught him that the X-ray examination is of the greatest assistance in intelligently handling cases. One should know the approximate size, shape, character, and location of the foreign body, and should endeavor to remove it with as little violence to the eye as possible. Rollet (*Arch. d'Opht.*, xxxii, p. 321, 1912) reports eighteen cases of extraction with the giant magnet. In two of foreign body in the cornea and iris the results were good; vision over 2/3 in both. Of the sixteen cases of foreign body extracted from the posterior segment of the eye, two eyes required enucleation, in nine the eyeball was saved without vision, in three operable traumatic cataract was left, and in five visual acuity of ⅛ to 1, was attained. Sir (*Cent. f. p.*

Augenh., xxxv, p. 333, 1912. *Ophthalmology,* viii, p. 386, 1912) reports that 147 cases treated in the Bohemian clinic, in ninety-eight the foreign body consisted of steel. Removal from the anterior parts was always successful. Of forty-six cases in the interior of the eyeball, twenty-five were saved.

Lamb (*Ophthalmology,* viii, p. 507, 1912) thinks that the foreign body should not be removed through the wound of entrance in the cornea, but rather through a scleral incision preferably at the lower outer quadrant between the tendons of the inferior and external rectus. Inasmuch as the Volkmann giant magnet cannot always be readily brought into the position desired, Gallemaerts (*Soc. Belge d'Opht.,* No. 30, 1912. *Ophthalmology,* viii, p. 68, 1912) has attached to the magnet movable poles, which may be of various forms like those of a hand magnet. In Risley's (*Ophth. Rec.,* xi, p. 258, 1912) case violent orbital cellulitis with panophthalmitis and profound general infection came on within twenty-four hours after magnet extraction of a rusty, friable scale of metal from the vitreous. The discharge contained Friedländer's bacillus, numerous streptococci and staphylococci. The reporter raised the question whether, in view of the rapid destruction of the organ by local mixed infection, the general infection was not already present at the time the injury was received; and the local condition secondary; or did the general disorder result from absorption of the local infection. The patient had suffered from a severe attack of pleuro-pneumonia a few years before, and was in poor health at the time the injury was received.

In Birkhaüser's (*Klin. M. f. Augenh.,* p. 23, July, 1911. *Ann. of Ophth.,* xxi, p. 150, 1912) case of *foreign body in the orbit,* sudden blindness of one eye followed perforation of the hard palate by a pipe stem. The x-rays showed that the foreign body had entered the orbit. The nerve was divided just anterior to the optic foramen, either directly by the foreign body itself, or through compression by the surrounding parts. A large region of the fundus around the papilla presented for some weeks a white discoloration with numerous hemorrhages; which appearances are believed by the reporter to have been due to edema from partial and temporary compression of the retinal and ciliary arteries.

Gallemaerts (*Acad. de Méd. de Belgique. Ophthalmology,* viii, p. 379, 1912) reports the result of an accidental injury to a child æt. 5, who fell and pierced the upper eyelid with a slate pencil, a fragment of which remained in the orbit for twenty-four hours. The extracted fragment measured 38 by 5 mm. Fetid pus mixed with air bubbles discharged from the wound. A drain 9 cm. long was shown by a

radiograph to penetrate the frontal lobe. Perfect recovery occurred after two months. Schoute (*Zeitschr. f. Augenh.*, xxvii, p. 185, 1912) reports a case in which a fragment of lead pencil 17 mm. long was supposed to have remained in the upper cul-de-sac of the conjunctiva for twenty-nine years. Both ends were imbedded in the tissue of the fornix, while the middle portion lay free in the conjunctival sac.

Forensic. Pertaining to a court of law. In medicine, that part of the science connected with judicial inquiry. Also, medical jurisprudence.

Forensic relations of ophthalmology. See major heading, **Legal relations of ophthalmology**; as well as **Visual economics.**

Foreshortening. This term is used in painting and drawing, and is applied to signify that a figure, or a portion of a figure, which is intended to be viewed by the spectator directly or nearly in front, is so represented as to convey the notion of its being projected forward; and, though by mere comparative measurement occupying a much smaller space on the surface, yet to give the same idea of length or size as if it had been projected laterally.

Forestus, Petrus. "The Batavian Hippocrates." See **Foreest, Pieter van.**

Fork, Fixation. A fixation fork devised *for insertion of sutures in the sclerotic* is described in the *Trans. Oph. Soc. U. K.*, p. 131, 1912. See **Fixation instruments.**

Forlenze, Joseph Nicolas Blaise. A well-known Italian ophthalmologist, who was born at Ricerno in 1769. He studied at first in various Italian and Greek universities, then, under Desault and Louis, at Paris, and under John Hunter at London. He settled as ophthalmologist in France, presumably at Paris. His death date cannot be learned.

Forlenze's ophthalmologic writings are as follows: 1. Considérations sur l'Operation de la Pupille Artificielle. (Strasburg and Paris, 1804.) 2. Observations et Reflections sur plusieurs Cataractes. (*Annuaire de la Soc. de Méd. du Department de l'Eure*, 1809.)—(T. H. S.)

Formaldehyde. FORMIC ALDEHYDE. METHYL ALDEHYDE. HCHO. This pungent and poisonous compound is made by the partial oxidation of methyl alcohol. Its solutions should be kept cool, in well-stoppered bottles, and away from the light. At ordinary temperatures formic aldehyde is a colorless gas with a pungent, irritating odor. Fifty per cent. solutions in water are obtainable, but at that strength the solution decomposes; hence the use of a weaker solution for surgical purposes.

Formaldehyde is incompatible with alkaline preparations, tannin, gelatine, and the salts of silver and copper.

Valude was the first to bring this valuable remedy to our notice as an antiseptic for ophthalmic use. In its pure form it proved very irritating, producing burning, smarting and lachrymation even when used in 1:1000 or 1:2000 solutions for conjunctivitis. More recently we have come to rely upon its 40 per cent. solution under the commercial title of formalin (q. v.), in which state it has proved a most valuable germicide and substitute for corrosive sublimate. Formaldehyde in its gaseous form is used as a disinfectant for ophthalmic instruments, special disinfectant apparatus having been devised for this purpose.

Formalin. FORMOL. LIQUOR FORMALDEHYDI, U. S. SOLUTION OF FORMALDEHYDE. This valuable antiseptic is the official solution, a colorless liquid with a burning taste and pungent odor, which has an irritant effect upon the skin and mucous membranes. It mixes in all proportions with water and alcohol.

It lessens secretion in almost all forms of conjunctival infection and for this particular purpose is employed in about the same proportion as corrosive sublimate. It is just as efficacious as that salt without possessing its irritant and poisonous qualities. As it does not form insoluble compounds with the tissues and is not incompatible with most of the remedies used in ophthalmic practice it is much to be preferred to bichloride of mercury. It is most valuable as a germicide, either alone or in conjunction with other remedies, in the proportion of 1-10,000 to 5,000. It is also excellent as a preservative of alkaloidal solutions in the 1-10,000 strength and it can be used, without damage to them, as strong as 1-100 for the preparation of instruments for operation.

H. McI. Morton uses formalin, one part to 80 as a direct application to corneal ulcers, and finds it more useful than the majority of applications he has employed.

E. C. Boyd prefers as a simple collyrium one drop of formalin in four fluid ounces of distilled water to be used in an eye-cup several times a day.

Occasionally cases of formalin amblyopia are published. For example, Sager (*The Ophthalmoscope*, February, 1906) reports a case in which a single drop was accidentally introduced into the eye of a patient. It was washed out with water within fifteen seconds. No pain was experienced until six hours afterward, when the eye became very painful and much inflamed. For a number of days the lids and conjunctiva were edematous. The cornea was steamy. Six months later the patient was seen by Sager, when it was found that the cornea was still slightly opaque, with vision reduced more than one-half.

Lewin and Guillery give the following history: A 45-year-old woman, while cutting grass, slightly injured her right eye. After a few days a physician dropped formalin solution, erroneously marked cocaine, into her eye. The pain increased. Drops placed in normal eyes also caused severe pain, and thus the mistake was recognized. The clinical picture was not closely studied, but after five weeks' treatment there was vision in the affected eye of only 6/200.

It must be remembered, also, that persevering with the local use of too strong solutions may set up a troublesome conjunctivitis.

Formation of the eye. See **Development of the eye.**

Formensinn. (G.) Form sense.

Formes frustes. (F.) Incomplete forms of Graves' disease.

Form, Estimation of. See **Form-sense.**

Formic acid. See **Acid, Formic.**

Formic aldehyde. See **Formaldehyde.**

Formidine. Methylene disalicylic acid iodide. $C_{15}H_{10}O_6I_2$. It is a reddish-yellow powder, nearly odorless and tasteless; contains about 46 per cent. of iodine and is marketed by Parke, Davis & Co. as a substitute for iodoform. It seems to be admirably adapted for use as a dusting powder in lid wounds, operative and other. It is found in sprinkler-top bottles.

Formol. See **Formalin.**

Formol-Müller fluid. This preservative—very useful in the preparation of museum and other laboratory ocular material—is made as follows: Potassium bichromate 2.5; sodium sulphate 1.0; formol 10.0; distilled water 100.0; or to 100 cubic centimetres of Müller's fluid ten cubic centimetres of concentrated formol solution. The specimen is fixed in from six to fifteen hours. Wash in flowing water for twenty-four hours. The formol is preferably added immediately before the solution is used, since the mixture loses its efficacy in a week.—(Fischer.)

Form-sense. This is the quality or power of the eye to distinguish the form of an object, and is of particular interest to the ophthalmologist because it is used in test letters and figures employed in determining the visual acuity. Test-types are for this reason sometimes called "forms;" thus, *forms of Snellen.*

Formula for the value of vision. See **Visual economics.**

Formyl tribromide. Bromoform. $CHBr_3$. This heavy, colorless liquid has a taste and odor resembling chloroform. It is an anesthetic and nervine sedative. See p. 1313, Vol. II, of this *Encyclopedia.*

Formyl triiodide or teriodide. See **Iodoform.**

Fornices. Plural of fornix; in ophthalmology, generally the fornix conjunctivæ (q. v.).

Fornicoblepharon. (G.) Abnormal union of the conjunctival membranes of the fornix.

Fornix conjunctivæ. CONJUNCTIVAL CUL-DE-SAC. FORNIX (GERLACH). FOLDS OF TRANSMISSION. These terms are applied to the parts and the locality where the conjunctiva of the lid is reflected upon the eyeball—there to become the ocular conjunctiva. Dwight (Norris and Oliver's *System*, Vol. 1, p. 122) says that when the eyes are open the fornix is about thirteen millimetres from the edge of the upper lid, while it is but nine millimetres from the lower lid. On the sides also the sac varies in depth, forming at the lateral angle a shallow pocket five millimetres deep, but at the medial angle becoming almost obliterated by the semilunar fold, under which it passes for only two millimetres. The fornix is five millimetres from the orbital rim above, six millimetres below, and four millimetres at the lateral angle. (Gerlach.) Its distance from the cornea is stated by Testut to be ten millimetres above, eight millimetres below, fourteen millimetres at the lateral angle, and seven millimetres at the medial angle. Merkel gives the distance above as eight millimetres; below, ten millimetres. It doubtless varies considerably with the prominence of the eyes. See, also, **Cul-de-sac, Conjunctival.**

Förster's self-registering perimeter. See **Perimetry.**

Fortification spectrum. FORTIFICATION SCOTOMA. TEICHOPSIA. This is a peculiar subjective, visual sensation in migraine. Its outer edge assumes a luminous, zigzag form, with angles like those of a fortification. See **Migraine.**

Fortpflanzung. (G.) Propagation.

Fortsatz. (G.) Process; apophysis.

Fortschreitender Staar. (G.) Progressive cataract.

Fortsetzung. (G.) A continuation; prosecution; extension.

Fossa glandulæ lacrimalis. FOSSA GLANDULARIS. FOSSA LACHRYMALIS. The depression in the frontal bone for the reception of the lachrymal gland.

Fossa, Hyaloid. FOSSA HYALOIDEA. LENTICULAR FOSSA. The depression in the anterior surface of the vitreous body for the crystalline lens.

Fossa hypophyseos. (L.) Pituitary fossa.

Fossa, Lenticular. See **Fossa, Hyaloid.**

Fosse. (F.) Hole; pit; depression; fossa.

Fosse des nerfs oculo-musculaires. (F.) The small depression on the surface of the crus cerebri, which lodges the motor oculi.

Fossula of the cornea. A deep ulcer of the cornea with a clear base in process of healing.

Foster, Gard. Wilmarth. A prominent ophthalmologist and otolaryngologist of Auburn, New York. Born at Burlington, Vt., June 15, 1853, son of the Rev. Salmon H. Foster and Jane Ann Tripp Foster, he received the medical degree at Detroit Medical College in 1873. He was for a time surgeon to St. Luke's Hospital, New York City, and, in 1882, to the New York Ophthalmic Hospital. About this time he settled in Auburn, where he resided until his death.

Dr. Foster married, May 12, 1898, Cornelia E. de Zeng.

He was a medium-sized man, of fair complexion, with blue eyes and white, curly hair. He was a collector of fine books, and an omnivorous reader. He was especially friendly and helpful to the younger men in his specialty, was a Republican in politics, and took a great interest in public affairs. He was also interested in all charitable work, and founded The Auburn Free Dispensary for Worthy Poor.

Dr. Foster died while on his way to Bermuda in search of health, Dec. 2, 1914, at Schenectady, N. Y., from pneumonia, after a surgical operation.—(T. H. S.)

Fötales Auge. (G.) Fetal eye.

Fötale Augenspalte. (G.) Fetal ocular fissure.

Fothergill's disease. Trigeminal neuralgia.

Fotometro. (It.) Photometer.

Foucault, Jean Bernard Léon (1819-68), French physicist, was born in Paris. He improved Daguerre's photographic processes, and conducted, in cooperation with Fizeau, investigations on the properties of light. He was enabled to demonstrate in 1850 that the velocity of light is greater in air than in water, and that in different media the velocity varies inversely as the refractive indices of the respective media. In 1857 Foucault invented his polarizer; and two years later (1859) his reflector for the great telescope at Paris was completed. Foucault also invented apparatus for the better application of the electric light. He edited the scientific part of the *Journal des Débats* from 1845, and was elected a foreign member of the Royal Society of London in 1864.—*(Standard Encyclopedia.)*

Foucault's prism. Sometimes (and erroneously) written *Foucauld.* The prism in which a film of air is substituted for the Canada balsam used in the construction of Nicol's prism (q. v.). The air-film permits of considerable shortening of the calcite (q. v.) rhomb, yet there is more loss of illumination by reflection than in the longer and consequently more expensive Nicol's prism.

Foucher, Jean Thimothée Emile. A celebrated Parisian surgeon and

ophthalmologist, who was born in 1823 and died in 1867. He was prosector to the Paris Faculty, and delivered the supplementary courses in ophthalmology. He is said to have written 141 works and articles. His chief ophthalmologic writing is "Du Glaucome, de sa Nature, de son Traitement" *(Rév. Thér. Médico-Chir.).* He also translated Wharton Jones's "*Diseases of the Eye*" (Paris, 1866).—(T. H. S.)

Foudroyant. (F.) Fulminating; crushing; sudden and overwhelming.

Fouillioy, Louis Mathurin. A French naval physician, who paid considerable attention to ophthalmology. Born at Landerneau, Dec. 23, 1790, he received his medical and surgical degree in 1813, at Brest, in the "Ecole de Santé." He was a very remarkable operator on every portion of the body, and invented a number of amputations and prosthetic apparatuses. In 1843 he settled in Paris as Adjunct General Superintendent of Naval Sanitary Affairs, and two years later became the superintendent in chief. He died Nov. 15, 1848.

Fouillioy's chief ophthalmologic writing is entitled "Notice sur un Procédé de Ténotomie Oculaire, Démontré et Pratiqué a l'Hôpital de la Marine de Brest" (*Annal. Marit. et Colon,* 1841; *Gaz. des Hôpit.,* 1841).—(T. H. S.)

Foulage. (F.) A form of manipulation of the tissues in massage.

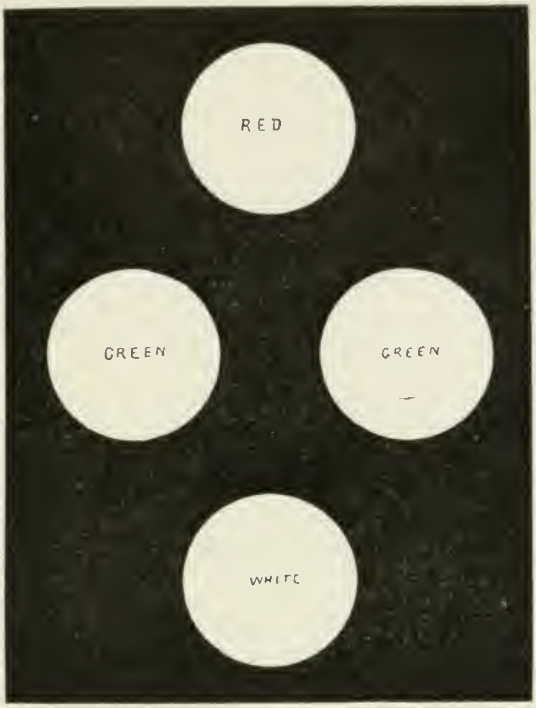
Foulé. (F.) Sprained.

Four-dot test. A test for binocular vision, devised by Worth (*Squint,* p. 14). It is a modification of the well-known Snellen colored-glass test. A piece of plain ground glass, 12 inches by 9 inches, is covered on the back with opaque black paper. The black paper has four round holes cut in it, each 3 inches in diameter, as shown in the diagram. The lower hole is left clear. Behind the upper hole is cemented a piece of red glass. Behind each of the other two is cemented a piece of green glass. The arrangement can either be hung up in a window or mounted in front of an electric or other light. (See fig. on next page.)

The patient, standing five or six yards away, wears a trial frame with a red glass before the right eye and a green glass before the left. If now he sees two dots (white and red) he is using the right eye only. If he sees three dots (white and two green) he is using the left eye only. If he sees four dots (white, red, and two green) he uses both eyes, and has at least grade 1 binocular vision. If he sees five dots (red, two green, and the white seen double) he has diplopia. If the accuracy of the patient's answers be doubted, it may be tested by changing the glasses in the spectacle frame from one eye to the other.

Fourmi. (F.) Ant.

Fourmillement. (F.) Formication.



Worth's Four-dot Test.

Fournier de Pescay, François. A well-known French surgeon, who paid considerable attention to ophthalmology. Born Sept. 7, 1771, at Bordeaux, France, the son of a San Domingan planter, he studied medicine at Paris, and became a military surgeon. After a number of years of military service, he settled in Brussels, where he became at the Secondary School professor of pathology and co-founder of the Societé de la Médicine, Chirurgie et Pharmacie and sole founder of a journal, "*Nouvel Esprit des Journaux.*" He afterwards lived at Paris, at Port-au-Prince, and at Pau. While his home was at Pau he passed away; the date of his death is, however, uncertain.

Fournier de Pescay translated, together with Bégin, Scarpa's "*Traité des Principales Maladies des Yeux*" (2 vols., Paris, 1821).—(T. H. S.)

Fourth nerve, Paralysis of the. Trochlear paralysis is seldom found alone. It is usually caused by syphilis, tabes, multiple sclerosis, and meningitis at the base of the brain, and by pressure in the valve of Vieussens. It may be assoeiated with third- and sixth- nerve

paralyses from diseases affecting those nerves.—(J. M. B.) See, also, **Neurology of the eye**.

Fourth nerve. PATHETICUS. TROCHLEAR NERVE. This is the smallest of the cranial nerves. It enters the orbital cavity through the sphenoidal fissure, and is distributed to the superior oblique muscle on its upper surface. It consists of about 2,000 coarse fibres, which innervate a muscle having about the same number of fibres.

Fovea centralis. FOVEOLA CENTRALIS. FORAMEN CENTRALE. The very centre of the retinal yellow spot or *macula lutea*. It is placed nearly in the axis of the globe at an average distance of 3.915 millimetres from the centre of the optic disk and 0.785 millimetre below the horizontal meridian (Landolt), a distance which varies according to the shape of the ball, being greater in hypermetropes and less in myopes. It is the region of most acute vision, and it is because of the localized character of this acuity that the eye must be moved when scanning carefully a surface of any extent. Its diameter is from 0.2 to 0.4 millimetre, and it is so deep that the retina at its bottom or fundus is thinner than at any other place, being only 0.1 to 0.08 millimetre thick. With the ophthalmoscope it can usually be discerned as a clear speck situated in the darker area of the yellow spot. See, also, **Histology of the eye**; as well as **Fundus oculi.**

Fovea externa. The outer depression, described by Schäfer, in the macula lutea.

Fovea interna. The inner of the two depressions described by Schäfer as occurring in the human macula lutea.

Fovea patellaris. (L.) An indentation or depression in the anterior surface of the vitreous formed by the membrana hyaloidea, for the reception of the crystalline lens.

Fovea retinæ. (L.) FOVEOLA. A very small, dark spot in the fovea centralis retinæ where the hexagonal pigment shows, owing to the thinness of the retina at this point.

Foveau-Trouvé apparatus. A device for **phototherapy**. It consists of a parabolic mirror with an incandescent or arc lamp in the focus; the former is joined to a concentrating cone which terminates in two quartz plates with a chamber between them; cold water circulates through this chamber and through the whole apparatus, absorbing the heat-rays. The quartz plate is pressed directly upon the part to be treated. (Gould.)

Foveola. A synonym of fovea *(centralis)*.

Fowler's solution. LIQUOR POTASII ARSENITIS. This solution of potassic arsenite really contains about one per cent. of arsenic trioxide, two per

cent. of potassium bicarbonate and three per cent. of compound tincture of lavender.

Arsenical compounds are rarely applied directly to the eye, but in the treatment for trachoma J. G. Dorsey uses a mixture containing Fowler's solution.

Fowl, The. Hen. Cock. The various products of the domestic, or barnyard, fowl, cock or hen, were highly esteemed in Greco-Roman times as remedies for many diseases and even for wounds of the eye. Chicken broth was thought to be especially valuable in epiphora. The dung of a red hen was an excellent remedy for nyctalopia (q. v.). The gall of a white hen was good for "suffusio" (cataract), caligo, albugo, and the various sorts of ocular ulcers. The white of an egg possessed an especial virtue in blennorhea neonatorum, and, mixed with various other medicaments, was employed as a poultice to the forehead or eyes. The yolk of the egg, raw or cooked, was believed to be an ocular anesthetic.—(T. H. S.)

Fox. According to Pliny (XXVIII, 47) the tongue of a fox, worn in a bracelet, or armlet, is a protection against lippitude.—(T. H. S.)

Foyer. (F.) Focus.

Foyer réel. (F.) Real focus.

Foyers conjugués. (F.) Conjugate foci.

Fractures. Injuries involving the bones of the head will be discussed under various appropriate captions, especially under **Orbit** rubrics; and **Injuries of the eye.** Here a few observations will be made, introductory to these studies, regarding fractures of a few of the facial and cranial bones, and the effects of these traumatisms on the ocular apparatus.

Fracture of the cranial bones often implicates the optic foramen. Parsons (*Pathology of the Eye*, p. 1182) points out that in v. Hölder's cases two-thirds were shot wounds, and one-third affected the head. Nine-tenths of Leber's cases were due to falls on the head; others were due to blows on the head, etc. The injury may also occur during birth from forceps pressure. Blows on the skull in any situation may cause the injury; shot wounds are usually suicidal through the mouth. v. Hölder records a case in which the patient was run over, Vossius one in which the patient fell while in a sitting posture.

Prescott Hewett found that the fracture extended into the orbital roof in twenty-three cases out of sixty-eight fractures of the base: v. Hölder, in one hundred and twenty-four cases of fracture of the skull, found eighty-six fractures of the base, with seventy-nine of the orbital roof; in fifty-four, or sixty per cent., the walls of the optic foramen were broken.

Bergmann showed that frontal fractures and those passing forwards or inwards in the middle fossa all tend to pass through the foramen, the latter sometimes passing through both and surrounding the clinoid processes. The injury is, however, only occasionally bilateral.

Fracture of the orbital walls, involving the soft parts within the orbit, are usually complicated with those of the lids, except in impacted fracture. Under antiseptic surgical conditions a drain may be laid and the external wound sutured, when, if healing by first intention has set in, the drain may be removed after 24 hours, and the parts allowed to heal together. If a piece of skin has been completely torn or excised from the brows or lids a Thiersch graft may be applied. The wound should always be carefully probed to determine the extent of a possible foreign body and the X-ray examination should not be neglected. If the supraorbital fascia be opened catgut stitches may be put in, otherwise the wound should be fully sutured. In splintering and fracture of the bones accompanying external wounds in complicated fractures, the loose fragments should be removed by forceps. Those that remain attached by a good-sized band of periosteum which can be replaced and held in position, will heal if put in place. Fragments that may have pierced the soft tissues should be elevated, cleared from the tissues, properly replaced, and held by periosteal catgut sutures, metal clamps, or even by sutures placed in the soft tissues; then a bandage.

Fractures without solution of continuity of the external skin or mucous lining of the walls of the sinuses or the dura mater of the cerebral cavity are generally simple fractures. The complicated fractures, which open up the sinuses, need no direct form of surgical interference. They are generally upwards and inwards, or inwards and downwards, and lead to infective processes from tearing of the mucous membrane lining the pneumatic sinus. Displaced bones forming the inner-upper walls cannot be replaced except by external incision, which may be made below the eye-brow and the bones reposited by periosteal probes and forceps. The bones of the inner wall and of the nasal processes may be replaced by manipulation (through the nasal passages) with the flat nasal probe and held in place by nasal tampons. The treatment is usually combined with that of fracture of the nasal bones.

Fracture of the zygoma may extend into, and a piece of bone penetrate the maxillary antrum. This dislocation may be replaced by a forefinger of one hand in the patient's mouth, well behind the zygoma, and the splinter raised into place, the head being steadied by the operator's other hand. If this is not possible a strong resection-hook

is passed around the zygoma at the nasal process and by it the bone is pushed into place. If the fracture be complicated by an open wound then the splintered bone may be reached through the opening and raised by forceps.

In complicated, or old healed, fracture of this character, when the deformity is the only defect, it may be well to leave the matter alone, as no evil results have been reported from such conditions.

In old, healed fractures of the orbital rim, as well as in uncomplicated fractures, an external incision may be made, with resection of the bone, i. e., an osteotomy or an ostectomy, to reach the injured part, to free it from the impaction and replace it.

Direct fractures of the orbital rim are the rule. Indirect fractures, without misplacement of the fragments, require no operative interference. They are accompanied by indirect fracture of the orbital wall and usually with fracture of the base of the skull.

Direct fractures of the orbital walls are as a rule due to penetrating injuries of the orbit. They are isolated, and are more amenable to surgical intervention than the indirect forms. Under rigid antiseptic precautions one should freely open the wound of entrance, remove foreign bodies, bone splinters and secretions. Probing and irrigation are not to be done, as pathologic (infective) products may be carried deeper into the tissues. This rule is also to be remembered in dealing with orbital abscesses. Drainage through the opening will remove the secretions and lessen the danger.

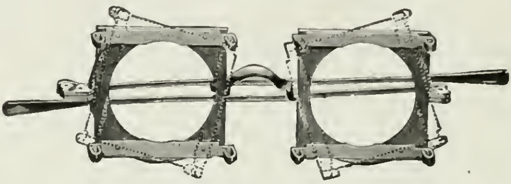
The operation for fracture of the roof of the orbit will best be conducted by an incision through the brow, with the skin well retracted and, if necessary, resection of the margin of the orbit, to reach safely the foreign body and remove it together with any bone splinters. The finger makes the best probe for the purpose of making a diagnosis; the splinters are seized and removed by forceps.

When the roof of the orbit is known to be fractured, a foreign body impacted therein and the eye-ball destroyed, enucleation of the globe or a partial exenteration of the orbit may be done. In this way direct access is given to the fracture, the foreign body and bone splinters are brought into view and easily removed, and the wound secretion better drained. All splinters should be taken away, as even very small ones may cause meningitis, brain abscess, and loss of life. If a localized brain, abscess common in bullet fractures, is found, it should be opened and drained.

In the lighter cases, when brain symptoms do not occur, the eyeball may be retained and simple drainage of the wound secured; but when the bulb is injured there should be no compunction about an

enucleation since we thus secure a satisfactory diagnosis and are better able to drain the depths of the wound.—(H. V. W.)

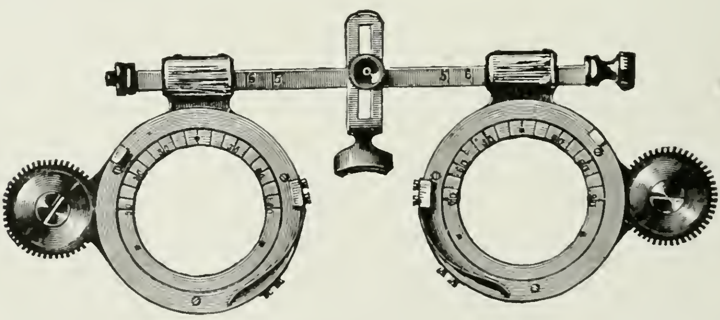
Frame for square prisms. The illustration of this device sufficiently explains its purpose and mode of employment. It is a useful and practical instrument in office practice.



Revolving Cell Frame for Square Prisms.

Frameless glasses. See **Eyeglasses and spectacles, History of.**

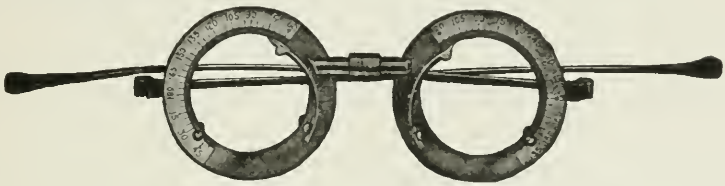
Frames of eyeglasses and spectacles. See **Eyeglasses and spectacles, History of.** Since spectacles are a necessity for infants in the treatment of squint, it becomes a problem how to adjust the frames without injuring the delicate tissues of the infant face. Hook temples do not answer, since, if heavy and strong, they produce abrasion, and if frail, they fail to retain the adjustment of the lenses. B. Harman (*Practical Med. Series*, p. 26, 1909) uses the following expedient: A piece of tape, elastic or not, is looped under the nucha, its ends threaded through the eyes of the spectacle bows, then carried on to the vertex, where they are tied together. This circuit of tape holds the spectacles firmly in position, yet allows of sufficient elasticity to avoid pressure on the nose, and the bows are not dragged down on the tops of the ears.



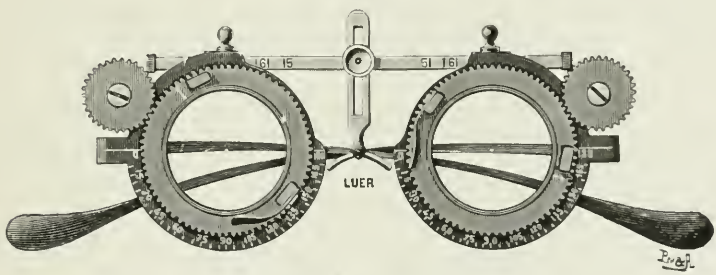
Burchardt's Test Frame.

Frame, Trial. TEST FRAMES. This important adjunct to the armament of the refractionist forms as numerous and as diversified a class—

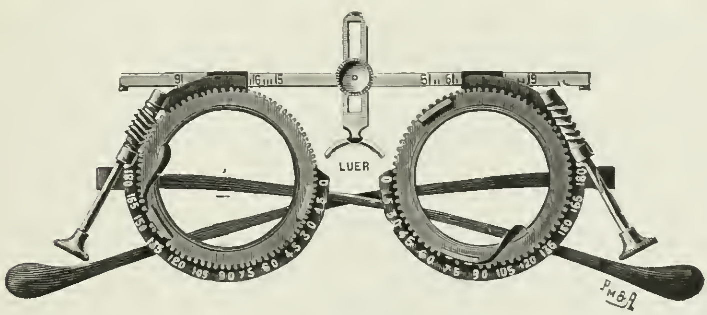
both simple and complicated—as any instrument employed by the ophthalmic surgeon. Trial or test frames have already been discussed and depicted under **Examination of the eye** (p. 437, p. 4731, Vol. VI), and elsewhere in this *Encyclopedia.* Here a few additional frames are pictured.



Nelson Black's Trial Frame.



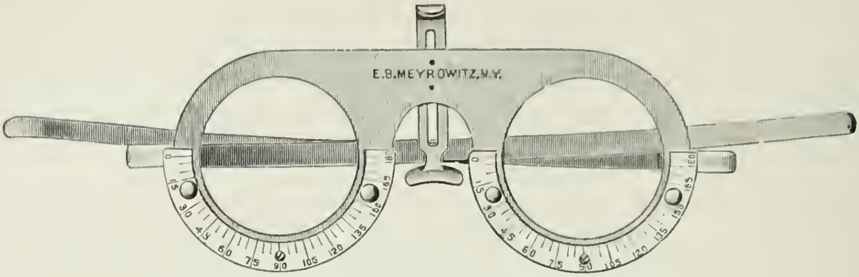
Trial Frame. (Luer.)



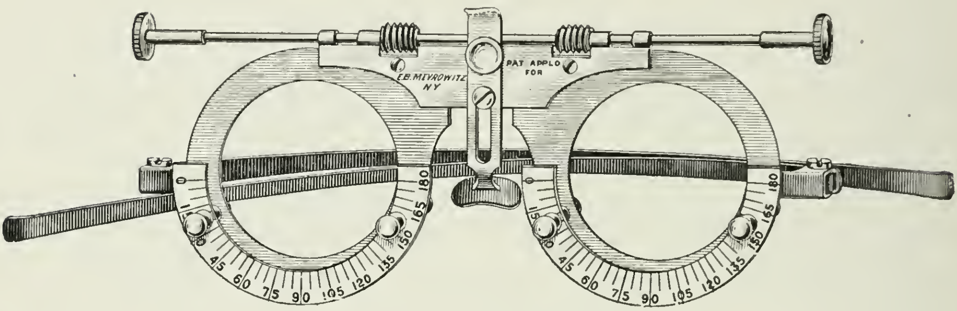
Luer's Simpler Trial Frame.

The trial-frame of Nelson Black is adjustable for any interpupil distance and has long, straight temples. It is comfortable for most patients, as the side does not come in contact with the delicate skin behind the ears.

The two Luer frames figured in the text have adjustable nose-pieces, lens-holders moved by a toothed disk in one case, in another by a simpler device, as well as other advantages readily seen on examination.



The So-called Clinical Frame, with Adjustable Nose-piece. Arranged for three pairs of lenses.



Improved Clinical Frame.

This frame is similar to the preceding, but is provided with a pupillary adjustment, operated from either side by means of thumb-screws; for three pairs of lenses.

France, Laws of, Relating to ophthalmology. See **Legal relations of ophthalmology.**

Franco, Pierre. A pupil of Paré, and, though chiefly a general surgeon, the greatest cataract depressor of the Renaissance, or, rather, post-Renaissance, period. He was born at Turiers, near Sisteron, Provence, about 1500. He led for many years the life of a wandering "cataract-sticker," "hernia-operator," and "cutter-for-stone." At last, however, he settled with some degree of permanence in Lausanne, Bern, and Orange of Provence. Concerning the cataract operation (which, in those times, was either depression or suction) he was very enthusiastic. Thus, he says, "Yes, I do assure you that, if I had to renounce either this cataract operation or all the rest of surgery, I would rather give up all the rest of surgery." Various details of his instructions for the cataract operation evidence unmistakably a wide personal experience as well as the very keenest powers of observation. Thus, in telling what to do, in case the cataract appears in the

pupil again after it has been depressed, he says that it must, of course, be couched again, *but not through the former opening*, for it is less painful, he declares (and rightly) to perforate the sclera anew than to pass the instrument in once more by way of the old opening. Franco died about 1561.—(T. H. S.)

Frangé. (F.) Fringed.

Frankenius, Johann. A Swedish physician and physicist, who wrote "*De Oculo*" (1651), a purely philosophical work. He was born in 1590 in the Province of Westermannland, settled in Upsala, and died in 1661.—(T. H. S.)

Franklin, Benjamin. This versatile genius, called by his enthusiastic compatriots, "the greatest American," "the embodiment of the genius of common sense," "the darling of American biography," "the greatest American diplomat," "the first American scientist," "the first of American journalists," "the second Prometheus," was also—a fact not commonly known—the inventor of bifocal spectacles.

He was born at Boston, in the colony of Massachusetts Bay, January 17, 1706. He was only in school four years. At the age of twelve he was apprenticed to his brother James, a printer, a man with whom he could never agree. In October, 1723, he proceeded alone to Philadelphia, whence he was sent by Keith, the governor of Pennsylvania, on some diplomatic errand to England. Three years later, he returned to Philadelphia, where, in 1729, he purchased the "*Pennsylvania Gazette*"—a publication which he proceeded at once to make useful and famous.

From that time onward, his success—journalistically, scientifically, diplomatically, and politically—was uninterrupted. He invented the musical glasses. He made the first successful stove. He organized the first police force and the first fire company in the colonies. He was really the founder of the University of Pennsylvania, and, admittedly, of the American Philosophical Society. He was, as every schoolboy knows, the first to demonstrate the absolute identity of the natural "lightning" with the artificial "electricity." This discovery alone would, of course, have entitled him to rank among the immortals.

We have no space in a work like this for even the barest list of Franklin's political and diplomatic activities. His achievements, moreover, in these particular categories, can easily be found in almost any history of the United States.

Ophthalmologically, I find, in the letters of Franklin, the following accounts of his own theories and achievements in the field of optics. The collection I believe to be absolutely exhaustive.

Letter to Mrs. Jane Mecom, London, 13 Jan., 1772: "I doubt you have taken too old a pair of glasses, being tempted by their magnifying greatly. But people in choosing should only aim at remedying the defect. The glasses that enable them to see *as well,* at the *same distance* they used to hold their book or work, while their eyes were good, are those they should choose; not such as make them see *better,* for such contribute to hasten the time when still older glasses will become necessary."

Letter to Edward Nairne, Passy, 18 October, 1783: "What you have heard of the eyes of sheep forced out by a stroke of lightning which killed them, puts me in mind of having formerly seen at Philadelphia six horses all killed by lightning in a stable, every one of whom appeared to have bled at the eyes, nose, and mouth, though I do not recollect that any of their eyes were out."

Letter to George Whately, Passy, 21 August, 1784: "Your eyes must continue very good, since you can write so small a hand without spectacles. I cannot distinguish a letter, even of large print, but am happy in the invention of double spectacles, which serving for distant objects as well as near ones, make my eyes as useful to me as ever they were. If all the other defects and infirmities were as easily and cheaply remedied, it would be worth while for friends to live a great deal longer, but I look upon death to be as necessary to our constitution as sleep. We shall rise refreshed in the morning."

Letter from George Whately to Franklin, London, 15 November, 1784: "I have spoken to Dolland about your invention of double spectacles, and, by all I can gather, they can only serve for particular eyes, not in general."

Letter from Franklin to George Whately, Passy, 23 May, 1785: "By Mr. Dolland's saying that my double spectacles can only serve particular eyes, I doubt he has not been rightly informed of their construction. I imagine it will be found pretty generally true, that the same convexity of glass, through which a man sees clearest and best at the distance proper for reading, is not the best for greater distances. I therefore had formerly two pairs of spectacles, which I shifted occasionally, as in travelling I sometimes read, and often wanted to regard the prospects. Finding this change troublesome, and not always sufficiently ready, I had the glasses cut and half of each kind associated in the same circle. By this means, as I wear my spectacles constantly, I have only to move my eyes up or down, as I want to see distinctly far or near, the proper glasses being always ready. This I find more particularly convenient since my being in France, the glasses that serve me best at table to see what I eat not

being the best to see the faces of those on the other side of the table who speak to me; and when one's ears are not well accustomed to the sounds of a language, a sight of the movements in the features of him that speaks helps to explain; so that I understand French better by the help of my spectacles."

Franklin died as the result of complications produced by a vesical calculus, April 17, 1790. The following characteristic epitaph was written by himself many years before his death:

THE BODY
OF
BENJAMIN FRANKLIN,
(LIKE THE COVER OF AN OLD BOOK,
ITS CONTENTS TORN OUT,
AND STRIPT OF ITS LETTERING AND GILDING)
LIES HERE FOOD FOR WORMS;
YET THE WORK ITSELF SHALL NOT BE LOST,
FOR IT WILL (AS HE BELIEVED) APPEAR ONCE MORE
IN A NEW
AND MORE BEAUTIFUL EDITION
CORRECTED AND AMENDED
BY
THE AUTHOR.

—(T. H. S.)

Franklin glasses. Bifocal spectacles with horizontally divided lenses. See **Franklin, Benjamin.**

Franklin's, Ladd, theory of color. See **Evolution theory of color-sensation.**

Franz, John Charles Augustus. The dates of his birth and death cannot be ascertained. He received his medical degree at Leipsic, Germany, practised for a long time in Brighton, England, and wrote "*The Eye, A Treatise on the Art of Preserving this Organ*" (London, 1839).—(T. H. S.)

Fraser, Thomas Richard. A Scotch pharmacologist, of some, if slight, ophthalmologic importance, because of his "Physiological Action of the Calabar Bean, Physostigma Venenosum" (*Trans. Roy. Soc. Edinb.*, Vol. XXIV). Fraser received his medical degree at Edinburgh in 1862, and became F. R. C. P. Edin. in 1869. The exact dates of his birth and death cannot be ascertained.—(T. H. S.)

Frattura. (It.) Fracture.

Fraunhofer's lines. *In physics*, a series of fixed lines in the solar spectrum first mapped out in 1814 by Fraunhofer, who designated

the more prominent of them by the capital letters A to H. See **Spectrum**; also **Achromatism.**

Fraunhofer, Joseph von. A celebrated German optician, the inventor of a machine for polishing mathematically uniform lenses, of the stage-micrometer, of a form of heliometer, of certain kinds of achromatic lenses, and, finally, the first to observe very carefully the dark lines of the solar spectrum, which lines, in consequence, are called to this day by his name. He was born at Straubing, Bavaria, March 6, 1787. His father was very poor, and, till his 14th year, the subject of this sketch could neither read nor write. Having become apprentice to a lens and looking-glass maker, he studied at night the more scientific aspects of his occupation. In 1806 he became optician in the Mathematical Institute at Munich. In 1809, with three of his friends, he established an optical institute at Benedictheuern, Bavaria. In 1814-15 he published in the "*Denkschriften der Münchener Akademie*" a series of articles in which "he laid the foundation of solar and stellar chemistry." He became Conservator of the Physical Cabinet at Munich in 1823, and died in that city June 7, 1826.

On his monument appear these words: "Approximavit Sidera!" —(T. H. S.)

Frébault, J. F. A French physician and ophthalmologist of mediocre ability. The dates of his birth and death cannot be ascertained. He received his medical degree, however, at Paris in 1806, presenting as dissertation "Sur les Hernies Abdominales." His only ophthalmologic writing is entitled "Observation sur un Cristallin qui a Passé par la Pupille dans la Chambre Antérieure de l'Oeil Droit, a la Suite de Cephalalgies Violentes et Chroniques, etc." (*Jour. Génér. de Méd.*, 1817).—(T. H. S.)

Freckles. Lentigo. See **Eyelids, Lentigo of the.**

Free cheeks. In certain of the *Crustacea*, the lateral, movable portions of the cephalic shield, which bear the eyes.

Freezing mixtures, Anesthetic. See **Anesthesia in ophthalmic surgery.**

Fremdkörper. (G.) Foreign body.

Fremdkörpermeissel. (G.) Spud, or foreign body remover.

Frémissement. (F.) Shivering; rigor; thrill; tremor.

French, Hays Clifton. A prominent Western homeopathic ophthalmologist. He was born in England, of Irish extraction, in 1840. In very early youth he removed with his father's family to America. His general education was received at the Western Reserve University, Cleveland, Ohio, and he was also graduated at the New York Ophthalmic Hospital in 1878.

In 1879 he formed a partnership with Dr. A. C. Peterson, of San

Francisco, widely known in homeopathic circles and a man of great ability. To Dr. Peterson, in fact, Dr. French was wont to ascribe an influence to which a large proportion of his own success was due.

Dr. French was one of the founders of the Hahnemann Hospital College, at San Francisco, and ably filled the chair of ophthalmology in that institution until failing health compelled him to resign the position as well as to relinquish a large and lucrative practice.

He died of paresis in 1901, aged 61 years.

Dr. French was about five feet eight inches tall, and was rather inclined to corpulency. He was, on the whole, decidedly handsome. His features were all fine and cleanly chiseled, and his complexion was soft and creamy. He wore a mustache, but no other beard. His eyes were blue and had that peculiarly merry twinkle found mostly in persons of Irish descent, but they were also capable of indignation and resentment. His hair was thick and wavy, and prematurely iron-gray. A colleague writes: "He possessed a fund of wit and humor, and could tell a story, that might be classed as slightly shady, or lead in prayer, with equal ease and impunity and almost in the same breath, as he was one of those fortunate persons who rarely give offense, and are allowed more than ordinary privileges. During the last few years of his life he was extremely religious; so much so that he became almost, if not quite, a religious monomaniac, through the loss of his little boy, whom he idolized and for whom he had high hopes and aspirations; and he became obsessed by the idea that the child's death was a punishment sent upon him because of his over-devotion to, and ambition for, the child. In the classroom he was a favorite with the students, for he was always genial, considerate and helpful. Dr. French had his faults and his foibles, but, taken altogether, he was above the average in ability and virtue."—(T. H. S.)

Frequency. The number of times any regularly repeated phenomenon occurs in a unit of time.

Frère Côme. A celebrated 18th century lithotomist and oculist. See **Baseilhac, Jean.**—(T. H. S.)

Fresenius, Johann Baptist Georg Wolfgang. A German botanist and physician, of some importance in ophthalmology. Born at Frankfort-on-the-Main September 25, 1808, he studied medicine at Heidelberg and Giessen, at the latter institution receiving his degree in 1829. Immediately thereafter he settled at Frankfort, and two years later became instructor in botany at the Senckenberg Medical Institute. Thirty-two years later his title was changed to "professor." He died December 1, 1866.

Fresenius wrote a great deal on botany, but his only ophthal-

mologic writing was "*Ueber die Traumatische Amblyopie und Amarose.*"—(T. H. S.)

Fresnel, Jean Augustin. A celebrated French military engineer and physicist, who established finally and absolutely the truth of the undulatory theory of light. He also very much enlarged our knowledge of diffraction and of the interference of light—both of which phenomena had been discovered by Grimaldi. He was born May 16, 1788, at Broglie, Department of Eure, Normandy, France. He studied at the Central School at Caen, at the Polytechnic School, and at the Ecole des Ponts-et-Chausées. He became successively Engineer in the Department of Vendée and Drôme, Engineer in Paris, Examiner at the Polytechnic School, and Fellow of the Academy. He received the Rumford Medal of the Royal Society in 1827, and shortly afterward (July 14, 1827) died at Ville d'Avray, near Paris.—(T. H. S.)

Fresnel lens. FRESNEL'S BIPRISM. A lens (bearing the name of its inventor) formed of a central plano-convex lens surrounded by segmental rings of glass. all having the same focus. The separate pieces are cemented to a plane glass or set in a metal frame. It is used in lighthouses and signal lamps. See **Fresnel, Jean Augustin.**

Fresnel's rhomb. A rhomb of glass so constructed that a ray of light may enter and emerge from it normally at either end, after being twice internally reflected through equal angles of incidence of 55 degrees at opposite sides of the rhomb. See **Fresnel, Jean Augustin.**

Freytag, Johann Conrad. A famous Swiss surgeon, of considerable importance in ophthalmology, being generally called the discoverer of membranous cataract. The date of his birth is unknown; the place, however, was Höngg, a village near Zürich. Before 1699 he was well established in Zürich, and was widely known as an operator, especially on the eye. He died in 1738.

Freytag left no ophthalmologic writing, but his son, Johann Heinrich *(q. v.)*, described his father's cataract procedures in a work entitled "*De Cataracta*" (Strasburg, 1721). According to this work, the elder Freytag "extracted" a cataract on three occasions. The "cataract," however, in each instance, was only a membranous cataract, and it was removed by means of a small hook, passed through a tiny incision. The first extraction in the modern sense was performed by Daviel in 1748. (See **Daviel,** in this *Encyclopedia.*)—(T. H. S.)

Freytag, Johann Heinrich. A Swiss surgeon, who paid considerable attention to ophthalmology. He was the son of the Zürich surgeon, J. C. Freitag (or Freytag), received his medical degree at Strasburg,

wrote "*De Cataracta*" (in which he described the cataract operation of his father) and died in 1725—thirteen years before his father.

Freytag was one of the less important opponents of the new doctrine concerning the nature and location of cataract. Throughout antiquity, the middle ages, and well on into the modern period, it was firmly believed that a cataract is a deposit of corrupt and inspissated "humor" in a (wholly imaginary) space between the pupil and the lens. Quarré, about 1643, first theoretically taught the true doctrine, and a German, Rolfinck, in 1656, confirmed his theory by anatomical dissection. The matter seemed soon after to have sunk into oblivion, until, in fact, Brisseau and Maître Jan, just after the beginning of the 18th century, re-discovered this most important truth, and compelled the scientific world to grant it recognition. Before, however, the recognition was accorded, a bitter contest arose concerning the question. The opposition to the new theory was led by Thomas Woolhouse, an English oculist resident in Paris. Among his followers was Freytag, the subject of this sketch.—(T. H. S.)

Fricke, Johann Karl Georg. A well-known German military surgeon, of slight ophthalmologic importance. Born at Braunschweig January 28, 1790, the son of a physician and professor of chemistry and physics, he studied medicine both at Braunschweig and at Giessen, at the latter institution receiving his degree in 1810. He then proceeded to Berlin, and completed his surgical training under Carl Ferdinand Graefe. He practised mostly at Hamburg, but was often engaged in military service in connection with various expeditions. Together with Dieffenbach and Oppenheim he published the "*Zeitschrift f. d. Gesammte Medicin.*" He died at Naples, whither he had gone in search of health, December 4, 1841.

His only ophthalmologic writing was "*Die Bildung Neuer Augenlider (Blepharoplastik) nach Störungen,*" etc. (Hamburg, 1829, 4 plates).—(T. H. S.)

Frick, George. The first American to publish a book on ophthalmology, and perhaps the first* to restrict his practice to diseases of the eye: on these grounds often called "The Father of American Ophthalmology." He was born in Baltimore, Md., in 1793. After an excellent education in the liberal arts and sciences, he entered the Medical Department of the University of Pennsylvania, receiving his degree in 1815. In 1817 he was admitted to practice by becoming a licentiate of The Medical and Chirurgical Faculty of Maryland.

For a number of years he studied abroad, paying considerable

*It would seem to be impossible to determine this matter exactly. The honor belongs either to Dr. Frick or to Dr. Henry Willard Williams, of Boston.

attention to ophthalmology. In Vienna he became acquainted with the great Beer, by whom he seems to have been profoundly influenced throughout the remainder of his life.

In 1819 he returned to Baltimore, began to practise ophthalmology, and seems to have had extraordinary success. Some years later, however, he became very deaf, and, in 1840, abandoned his practice entirely, and removed to Europe, returning to America from time to time for the purpose of visiting relatives and friends.

He never married. He was a shy, kind-hearted man, whom everybody loved, upright and honorable in all his dealings. He died in Dresden, Germany, March 26, 1870.

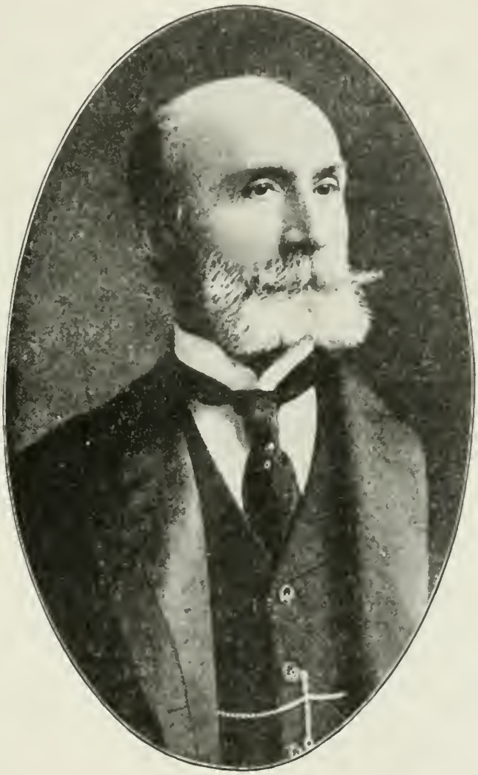
George Frick.

His most important journal articles are as follows:

"On the Meloe Vesicatorium" (1815); "Observations on Cataract and the Various Modes of Operating for its Cure" (*Am. Med. Recorder,* Phila., 1820-21); "Observations of the Various Forms of Conjunctivitis" (*Ibidem,* 1821); "Observations on Artificial Pupil and the Modes of Operating for its Cure" (1823).

The only book he ever wrote was that above referred to, entitled "*A Treatise on the Diseases of the Eye; Including the Doctrines and Practice of the Most Eminent Modern Surgeons and Particularly Those of Prof. Beer*" (Baltimore, 1823; 2d ed., with notes by Richard Welbank, London, 1826). Though based on the books of Beer, this first American work on ophthalmology contained a great deal of original matter and was written in a clear, forceful, even, beautiful style. On the whole, it was an appropriate beginning for American ophthalmography.—(T. H. S.)

Friebis, George. Born at Edelsheim, Germany, Dec. 18, 1847, he removed with his father to France in 1848, and, a few years later, to America. His general education was received in the Philadelphia public schools, his medical training from the Jefferson Medical College, where he received his degree in 1879. He at once became assistant to Prof. Wm. Pancoast, then Professor of Anatomy at Jef-



George Friebis.

ferson. Later he became successively Demonstrator of Anatomy, Lecturer on Diseases of the Skin, and assistant to Dr. Lawrence Turnbull, then Professor of Otology and Rhino-Laryngology in the Jefferson school.

In 1884, deciding to devote himself exclusively to ophthalmology, he became assistant to the famous professor of ophthalmology at Jefferson, William Thomson. In this position he served for eleven years, during the last six of which he was Clinical Chief and Lecturer on Diseases of the Eye.

In his private practice he confined his work almost exclusively to errors of refraction.

For many years he was assistant editor of "*The Medical Bulletin*," and to this and certain other journals he contributed a number of ophthalmologic articles.

He was a very courteous and honorable man, especially kind to the poor. He died suddenly January 26, 1912.—(T. H. S.)

Friedenwald, Aaron. A well-known American ophthalmologist and medico-economist. He was born December 20, 1836, at Baltimore, Maryland, the son of Jonas and Merle (Bar) Friedenwald. His early education was received at the school maintained by the Baltimore Hebrew Congregation. At the age of about fifteen, however, he had to relinquish his studies in order to accept a situation as bookkeeper in a clothing store. Finding the position uncongenial, he decided, when twenty-one years of age, to study medicine. For awhile he studied, after the custom of the day, with a preceptor, Dr. N. R. Smith. Entering, just a little later, the University of Maryland, he received from that institution his professional degree in 1860. He then went to Europe, where he studied ophthalmology, as well as general medicine, in Berlin, Prague, Vienna, Paris and London. While abroad he was chiefly influenced by Arlt and von Graefe, hence, for the remainder of his life, though he never wholly gave up general medicine, his heart was mostly in his work as an ophthalmologist. For a long time he was the only ophthalmologist in Baltimore.

In 1873 he was made professor of diseases of the eye and ear in the College of Physicians and Surgeons at Baltimore. In this capacity he labored with conspicuous success for twenty-nine years.

In 1889 he was elected president of the Medical and Chirurgical Faculty of Maryland. He was also the first president of the Maryland Ophthalmological Society.

Always interested in medical economics, especially in the part thereof relating to the communal life of physicians, he it was who, to all intents and purposes, created, in 1890, the present Association of American Medical Colleges. "It was on his motion, as a representative of the College of Physicians and Surgeons, that the Association of Baltimore Medical Colleges . . . became a national organization at Nashville." (*Annals of Ophthalmology*, October, 1902.)

Dr. Friedenwald was a man of social, even jovial, character. He was also upright, patriotic and very devoutly religious. His genial nature is characteristically shown by the fact that, during his daily

nap, which he took for a very few minutes after dinner, he always desired to have the children romping about him in the room, or at least a number of persons talking and laughing. Such matters never annoyed, they merely soothed and comforted him. His patients, too, were wont to say that the pleasant manners of Dr. Friedenwald were a kind of medicine in themselves.

Aaron Friedenwald.

That his genial nature was by no means unaccompanied by the extreme of firmness, whenever occasion demanded, could be shown by numerous anecdotes. Of these, let one or two suffice as being wholly typical. One day, when a student in the University Infirmary, he received an unsigned note, insulting to himself and his religion. Below the illiterate message, he penned these words: "The man who wrote the above lines is as great a coward as he is a scoundrel, or he would have signed his name. A. Friedenwald." And he posted the note. In a very short time, he was facing an angry crowd of

rowdies, some of whom demanded in language more vigorous than polite, if he had written "those words." Young Friedenwald responded so emphatically and stood so plainly ready to back his words with actions, that the rowdies, one by one, slunk out of view. In consequence of this affair, he was soon elected to membership in a very select and scholarly organization, known as "The Rush Club."

Here is yet another anecdote to the same effect. While still a student of medicine, he stopped one day at the clothing store kept by his brothers. A thief ran in, grabbed up an armful of clothes, and dashed out again—pursued, however, by the embryo doctor. The thief threw away the clothes, but Dr. Friedenwald was not to be diverted from the more important purpose. The scoundrel even drew a revolver, and, aiming it squarely at his pursuer's head, declared his intention to shoot. But still Dr. Friedenwald did not stop. He ran up, seized the fellow, threw him down, and, taking away his revolver, kept it aimed at the scoundrel's head until the arrival of a policeman.

Dr. Friedenwald's patriotism, too, could be shown by numerous examples. The following passage, however, from one of his letters, written to friends at Baltimore, while he was still a student at Berlin, may stand as representative: ". . . A few evenings since, being in a beer garden, I heard some one in the crowd whistling 'Yankee Doodle.' I was affected as by an electric shock, was almost involuntarily drawn to the spot, and found that the melody emanated from a respectable-looking, well-dressed young gentleman. I accosted him with, 'What right have you to whistle my songs?' No further altercation took place, he having established his right by stating that he was an American, and a Baltimorean at that."

As already suggested, Dr. Friedenwald was brought up in accordance with the strictest traditions of orthodox Judaism. We may now add that, from these old-time principles, he never swerved even to the last moment of his life. While still a student in Berlin, he wrote to his father: "Dear Father, you entertained great fears on my departure that I would entirely forget my religion, but rest assured that what I have seen of 'enlightened Judaism' here has disclosed our old, assailed, insulted orthodoxy in a more beautiful form than I have yet beheld it." At a very much later period, he used the following language: "Thank God that I have not been infected with that dangerous spirit of the age, which questions His existence. He who in His goodness has shielded me from the pernicious influence of the small-pox and cholera and yellow fever and other pestilences, has shielded me from this greater plague." He was a constant

attendant at the synagogue, and was one of the founders and also an officer of the Shearith Israel congregation. He was later a member of the Chizuk Emoonah congregation, in which he succeeded his father, Jonas Friedenwald, as president. He was always a student of the ancient Hebrew, kept numerous Hebrew books beside him on his desk, because of their cheering companionship, and now and then composed a letter to a friend in Hebrew.

He married, June 14, 1863, Miss Bertha Bamberger, to whom he had become engaged before he went abroad. Of the union five children were born, all sons: Harry, now a well-known ophthalmologist of Baltimore; Julius; Bernard Daniel; Norman; and Edgar Bar.

Dr. Aaron Friedenwald died at Baltimore, August 26, 1902, after an operation for cancer of the stomach. Memorial services were held in his honor at the McCulloh Street Synagogue, November 9, 1902, addresses being made by the Rev. Drs. Mendes, of New York City; Schnuberger, of Baltimore; Cyrus Adler, of New York; and Solomon Solis-Cohen, of Philadelphia.

Among the more important writings of Dr. Aaron Friedenwald are the following:*

1. "Letter from Berlin" (dealing with Glaucoma and Iridectomy), *Maryland and Virginia Medical Journal,* 1861, Vol. XVI, p. 349.
2. "The Pulse," a paper read before one of the Baltimore medical societies.
3. "Diseases of the Lachrymal Apparatus," a paper read before the Baltimore Medical Association, 1869.
4. "Sympathetic Ophthalmia," a paper read before the Baltimore Medical Association, 1869.
5. "Exophthalmic Goitre," a paper read before the Pathological Society of Baltimore, 1870 (?).
6. "Purulent Ophthalmia," a paper read before the Baltimore Medical Association. April. 1870.
7. "Traumatic Cataract," a paper read before the Baltimore Medical Association, April 24, 1871.
8. "Various Conditions of the Nerves of the Eye Regulating the Contraction and Dilatation of the Pupil," a paper read before the Medical and Surgical Society of Baltimore, May 4, 1871.

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*For the whole of this excellent bibliography, as well as for the most of the material used in the body of the sketch, I am deeply indebted to a book by Dr. Harry Friedenwald, of Baltimore, Md., son of Dr. Aaron Friedenwald, entitled "*Aaron Friedenwald, His Life, Letters and Addresses*"—a beautiful tribute, by the way, to a master ophthalmologist and old-time father in Israel.

9. "Iritis," a paper read before the Baltimore Medical Association, September, 1871.

10. "Retinitis Complicated with Bright's Disease," *Trans. Med. and Chir. Faculty*, October, 1871.

11. "Eczema," a paper read before the Medical and Surgical Society of Baltimore, February 8, 1872.

12. "Glaucoma," a paper read before the Baltimore Medical Association, November 11, 1872.

13. "Phlyctenular Ophthalmia," a paper read before the Medical and Surgical Society of Baltimore, May 1, 1873.

14. Introductory Lecture to the Course on Diseases of the Eye and Ear, delivered before the Class of the College of Physicians and Surgeons, Baltimore, October, 1873.

15. "Report on Surgery: Indications for the Enucleation of the Eye-ball and the Correction of the Deformity by the Insertion of an Artificial Eye," read before the Medical and Chirurgical Faculty of Maryland, April, 1876; *Trans. Med. and Chir. Faculty*, 1876, p. 82; also *Cincinnati Medical News*, November, 1877.

16. "Ophthalmological Notes" (including "Anaesthetics in Ophthalmic Surgery" and "Spasm of the Accommodation"), a paper read before the Medical and Chirurgical Faculty of Maryland, April, 1878; *Trans. Med. and Chir. Faculty*, 1878, p. 94.

17. "The Eye," a Lecture delivered before the Hebrew Young Men's Association of Baltimore, 1878.

18. "Optic Neuritis," a paper read before the Baltimore Medical Association, April 11, 1881; *Maryland Medical Journal*, August 1 and 15, 1881; also reprinted separately.

19. "Introductory Address delivered before the Class of the College of Physicians and Surgeons of Baltimore City, September 14, 1881, . . . Published by the Class."

20. "Address on the Occasion of the Dedication of the Newly Acquired Ground at the Simchath Thorah Festival of the Hebrew Hospital and Asylum Association of Baltimore City, October 16, 1881," published by the Association, Baltimore, 1881.

21. "Old Foes and New Friends," an Address upon Anti-Semitism, delivered before the Hebrew Young Men's Association of Baltimore (1882?).

22 "Enucleation and Optico-Ciliary Neurotomy," a Clinical Lecture before the Class of the College of Physicians and Surgeons; *Medical Chronicle* (Baltimore), Vol. I, 1883, p. 150.

23. "Four Cases of Syphilitic Brain Disease Complicated with Eye Disease" (1883?).

24. "Relation of Eye and Spinal Diseases," a paper read before the Medical and Chirurgical Faculty of Maryland; *Trans. Med. and Chir. Faculty*, 1883, p. 187; also reprinted separately. (Abstracted in *Medical News* [Philadelphia], Vol. XLII, 1883, p. 505, and in the *Maryland Medical Journal*, Vol. X, 1883-4, p. 25.)

25. "Uræmic Amaurosis," a paper read before the Baltimore Medical Association, June 9, 1883; *Medical News* (Philadelphia), April 9, 1884; abstracted in the *Medical Chronicle* (Baltimore), November, 1884.

26. "Recent Progress in Ophthalmology," a review of current literature, *Medical Chronicle* (Baltimore), August, 1883.

27. Address Commemorative of Dr. Andrew Hartman (December 15, 1884).

28. Address delivered at the Purim Banquet of the Hebrew Ladies' Orphans' Aid Society, Baltimore, February 27, 1885.

29. "Foreign Bodies in the Eye," a paper read before the Clinical Society of Baltimore, March 20, 1885.

30. "Four Cases of Eye-Injuries," described at the meeting of the Baltimore Medical Association, November 10, 1885; *Medical Times* (Philadelphia), December 12, 1885.

31. "Osteosarcoma at Base of Skull," *Maryland Medical Journal*, 1886, p. 500.

32. "A Case of Optic Neuritis with Brain Symptoms; Recovery, with Remarks," a paper read before the Clinical Society of Baltimore, December, 1885; *New York Medical Journal*, February 5, 1887.

33. Address Commemorative of Professor John S. Lynch, M. D., delivered before the Medical and Chirurgical Faculty of Maryland, October 7, 1888; published in abstract in *Trans. Med. and Chir. Faculty*, 1889, p. 42.

34. "Disturbed Equilibrium of the Muscles of the Eye as a Factor in the Causation of Nervous Diseases," a paper read before the Medical and Chirurgical Faculty of Maryland; *Trans. Med. and Chir. Faculty*, 1889, p. 199; also reprinted separately.

35. "Iodoform in Gonorrhœal Ophthalmia," a paper read before one of the Baltimore medical societies, 1889.

36. Address delivered at the Opening of the New City Hospital, Baltimore, January 1, 1889.

37. "Detachment of the Retina," a paper read before the Baltimore Medical Association, November 11, 1889; *Maryland Medical Journal*, Vol. XXII, 1889, p. 205.

38. Address at the Semi-Annual Session of the Medical and Chir-

urgical Faculty of Maryland, Hagerstown, November 12, 1889; published in part in *Trans. Med. and Chir. Faculty*, 1890, p. 10.

39. Address delivered at the Simchath Torah Festival of the Hebrew Hospital and Asylum Association, 1890.

40. "The Modern Hospital," Presidential Address before the Medical and Chirurgical Faculty of Baltimore, 1890; *Trans. Med. and Chir. Faculty*, 1890, p. 145; also *Maryland Medical Journal*, Vol. XXIII, 1890, p. 1.

41. "Jewish Immigration," an Address, published in the *American Hebrew* (New York), (1891?).

42. Address at the Celebration in Honor of the Seventieth Birthday of Professor Virchow, held in the Johns Hopkins University, Baltimore, October 13, 1891; published in the *Johns Hopkins University Circular*.

43. "Charity," an Address delivered at the Annual Banquet of the Hebrew Benevolent Society, Baltimore, December 1, 1892.

44. Address delivered at the Annual Meeting of the Baltimore Branch of the *Alliance Israélite Universelle*, March 19, 1893.

45. "Paralysis of the Eye Muscles of Central and Peripheral Origin," a paper read before the Medical and Chirurgical Faculty of Maryland, April, 1894; *Maryland Medical Journal*, May 26, 1894; also reprinted separately.

46. "Lovers of Zion," an address delivered before the Mickvé Israel Association of Philadelphia, December 23, 1894; published in the *Jewish Exponent* (Philadelphia) and reprinted by the Zion Association of Baltimore.

47. "Jewish Physicians and the Contributions of Jews to the Science of Medicine: a Lecture delivered before the Gratz College of Philadelphia, January 20, 1896"; *Publications of Gratz College*, No. 1; also reprinted separately, Philadelphia, 1897.

48. "A Trip to Palestine," an Address read before the Young Men's Hebrew Association of Philadelphia, February 25, 1899, and also before societies in Baltimore and New York; published in the *Jewish Exponent* (Philadelphia).

49. "Glimpses in Palestine," an Address delivered before a Jewish society in Baltimore (1899?).

50. "History of Medicine before Hippocrates," a paper published in the *Journal of the Alumni Association of the College of Physicians and Surgeons*, April, 1900.

51. "Circumcision" (Medical Aspects), an Article in the *Jewish Encyclopedia*, Vol. IV.

52. "Doctor George H. Rohé: A Memoir," read at the Memorial

Meeting of the Maryland Health Association, May 23, 1901; published in pamphlet form.

53. "Removal of the Crystalline Lens for High Degrees of Myopia," *Journal of the Alumni Association of the College of Physicians and Surgeons,* Baltimore, July, 1901.

54. Address at the Celebration held in Honor of the Completion of the Twenty-fifth Year of the Reverend Dr. Henry W. Schneeberger's Service as Rabbi of the Chizuk Emoonah Congregation, Baltimore, October 20, 1901.

55. "The National Jewish Hospital for Consumptives," an Article published posthumously in the *Jewish Comment* (Baltimore), November 14, 1902.—(T. H. S.)

Friedlaender, Ludwig Hermann. A well known German military surgeon of a little ophthalmologic importance because of his "*De Medicina Oculorum apud Celsum Commentatio*" (1817). He was born at Königsberg, Prussia, April 20, 1790, studied both there and at Berlin, settled in Halle, there became privat-docent in medicine, in 1819 extraordinarius and in 1823 ordinarius of theoretic medicine, and died in 1851.—(T. H. S.)

Friedländer's bacillus. BACILLUS PNEUMONIÆ FRIEDLANDERI. This organism was first obtained from the exudates in the pulmonary aveoli in cases of croupous pneumonia. It is aërobic, as well as facultative anaërobic. It is a large, non-liquefactive, non-motile, Gram negative, capsulated bacillus, which grows very profusely on ordinary media and furnishes a typical "nail culture" in gelatine. Pure infections of the conjunctiva with Friedländer's bacillus have been frequently noted. The organism is probably identical with *Bacillus mucosus capsulatus.* See **Bacteriology of the eye.**—(S. H. M.)

Friedreich's disease. See **Hereditary diseases**; as well as *family ataxia* under **Familial affections,** and page 662, Vol. I of this *Encyclopedia.*

Frisson. (F.) Rigor; shivering; shiver.

Fritschi. An almost wholly unknown privat docent at Freiburg, who wrote: 1. Die Bösartigen Schwammgeschwülste des Auges und seiner Nächsten Umgebung. (Freiburg, 1843.)

2. Uber die Wirksamkeit einiger Arzneimittel gegen Augenleiden, Besonders gegen Gewisse Formen der Augen-Entzündung. *Jour. d. Chir. u. A.*, vol. 36, pp. 62-150 and 223-273, 1847.)—(T. H. S.)

Frog. The frog, in Greco-Roman antiquity, was supposed to be of value in various diseases of the eye. Thus, the fluid which could be scraped from a frog's back was employed in a general way as a strengthener of the sight. The flesh was laid upon an eye as a styptic

and analgesic. The blood was also used to prevent the return of cilia after epilation. The most remarkable use of all, however, was that for which the elder Pliny is alone responsible. At the time of the new moon, the eyes were torn from a living frog, and then, enclosed in either a cloth or an egg-shell, carried by a patient for either an *albugo* or a *lippitude*. Great care, however, was necessary that the right eye of the frog should be worn on the left side of the patient, and *vice versa*.—(T. H. S.)

Frog's mouth mucosa. The membrane lining the mouth of the common frog has been used both in ophthalmic and general surgery.

Leslie Paton (*The Lancet,* April 23, 1904) operated upon an eye in which there was complete attachment of the lower lid to the eyeball causing limitation of movement and diplopia in every direction so that the fellow eye had to be covered constantly. He used membrane from the roof of the frog's mouth to form a re-lining of the lower conjunctival sac. He says that three frogs were used and from these, three flaps were prepared, the largest being about two centimetres in breadth; the other two, from smaller frogs, were approximately the same breadth but shorter. These were kept in warm sterilized saline solution while the eye was prepared. In dissecting the surface, care was taken to leave any normal conjunctiva attached to the ocular surface. The dissection was carried down until over a centimetre of raw palpebral surface was exposed. To this the larger piece of mucous membrane was attached by four fine silk sutures along the upper margin, the lower margin being left unattached. The other two pieces of mucous membrane were similarly sewn to the fringe of conjunctiva on the ocular surface. They were carefully arranged in position and a piece of green protective was pushed in and the eye closed and bandaged. On the sixth day the protective was taken out and the stitches removed. All three grafts had taken, the palpebral one and the outer ocular one perfectly, the inner ocular one not quite so well, and at the line of its suture there was a fleshy granulation. The movements of the eye were now free except that on extreme movement outward there was some diplopia.

At the time of writing the appearance of the eye was almost natural. There was an irregularity of the lower lid margin, which, however, was not marked. On pulling down the lower lid at the inner margin there was one cicatricial band passing to the eye about a centimetre in length and about three millimetres in breadth. In the rest of its extent the conjunctival sac was almost normal in appearance.

Frog's spawn. The appearances of the granular form of trachoma—the gray, translucent, hemispherical bodies also called "sago grains."

Froid. (F.) Cold; coldness.

Froidure. (F.) Congelation; freezing.

Froissement. (F.) Bruising; contusion (by violent friction).

Frölich's test. This test for simulated blindness is a modification of Monoyer's examination with double prisms. The inventor added to the double prism a red glass which can be adjusted sometimes before the two prisms placed base to base and sometimes before the space which separates them; sometimes before one or the other prisms. In either case three images are formed in the Frölich test. The upper and the lower, or the single middle image, can thus be colored red at the will of the examiner. The apparatus is more complicated than that of Monoyer. The fact that the second red glass, which is placed before the eye that is said to be defective, must render difficult the incessant surveillance that is indispensable to exercise in order to prevent a malingerer from closing the eye and discovering the number and color of the images which it is to his interest to declare that he sees or does not see. For this reason this test is less valuable than others described under **Blindness, Simulation of.**

Fromage. (F.) Cheese.

Froment. (F.) Wheat.

Fromont's figures. Images used in the stereoscope of the inventor, and described in Javal's *Manual de Strabisme*, 1896.

Fronce. (F.) A furrow.

Fronde. (F.) Four-tailed bandage.

Fronmüller. A well-known German physician and ophthalmologist, inventor of the trial-case,—i. e., the case of trial lenses, frames, etc., substantially as used today. The dates and the place, or places, of his birth and death cannot be ascertained. He was the son of a physician, and he practised at Fürth. For the earliest accounts of his excellent and memorable invention, see *Jour. d. Chir. u. Augenheilk.*, Vol. 32, p. 174-187, 1843, and *Annales d'Oculist*, Vol. x, p. 283, 1843.—(T. H. S.)

Frontal bone. See **Cavities, Neighboring**; as well as **Anatomy of the eye.**

Frontal distance. The space between the objective and the cover glass when the object is in focus.

Frontal nerve. One of the three branches of the first division of the fifth nerve. See **Fifth nerve.**

A method of resecting the external frontal nerve and its branches has been described by Motais (*Ophthalmic Year-Book*, p. 44, 1913).

A $2\frac{1}{2}$ to 3 cm. incision is made below the arch of the orbit, extending through the skin and orbicularis. The aponeurosis is similarly opened, and the orbital notch found with the finger. To catch the nerve a strabismus hook may be passed under the roof of the orbit. The nerve being isolated is seized with forceps, dissected out and divided 5 to 12 mm. back from the orbital margin. The slight hemorrhage is arrested by pressure. By this procedure the principal branches of the nerve are secured and removed.

Frontal sinus. See **Cavities, Neighboring.**

Frontal vein. This is a large vessel running along the inner side of the orbit and communicating with branches of the ophthalmic vein. According to Dwight, a branch connecting it with the anterior temporal forms an arch along the top of the orbit. The facial vein receives some distance below the orbit a vein from its outer border. The branches in the lids do not form definite arches like the arteries, but run in the main at right angles to the palpebral opening. The artery lies a little higher. Merkel points out that most of the superior branches and all the internal ones pass through the orbicularis, so that its continued contraction must cause a congestion. Probably under these circumstances more of the blood passes off into the cranium or into the system of the internal maxillary vein, but under ordinary circumstances the current is superficial.

Front focus. See **Focus.**

Fronto-lachrymal. Belonging to the forehead and to the lachrymal bone.

Fronto-maxillary fissure. See **Development of the eyes.**

Fronts. Grabs. Colloquial names for the lenses temporarily attached to spectacles, to increase their visual powers.

Front-stop. In *optics*, an annular diaphragm centrally placed in front of a lens-system in order to restrict the aperture to bundles of *effective rays.* In the absence of a stop the circular rim of a single lens is the common base of the cones of incident and refracted rays that take part in the production of the image, which is, consequently, less free from distortion. See, also, **Aperture.**—(C. F. P.)

Froriep, Robert. A celebrated German pathologist, of a slight ophthalmologic importance because of his "*De Corneitide Scrofulosa*" (1830). He was born at Weimar, Feb. 21, 1807, received his medical degree at Bonn in 1828, studied also in Paris, and in 1830 made his home in Jena. He later resided in Berlin and Weimar. At the latter place he died, June 14, 1861.—(T. H. S.)

Frost-Lang operation. See **Enucleation of the eye.**

Frothingham, George Edward. Born at Boston, Mass., April 23, 1836, he received his liberal education at Phillips Academy, Andover. For a time he taught school. Then he began to study medicine with Dr. W. W. Greene, Professor of Surgery in the Medical Department of Bowdoin College. Later, he proceeded to Ann Arbor, Mich., where he received the degree of M. D. in 1864.

George E. Frothingham.

Returning to Massachusetts, he practised for three years at North Becket. Then he returned to Ann Arbor, in order to accept the demonstratorship of anatomy and the prosectorship of surgery in his *alma mater*.

Deciding to devote himself to ophthalmology and oto-laryngology exclusively, he studied for a time in the ophthalmic and aural hospitals of New York. Then, returning to Ann Arbor, he was appointed full professor to the chair of ophthalmology and otology, then just created. As a matter of convenience to the faculty, he taught, at times, in addition to his own branches, anatomy, materia medica, and

therapeutics. He was a genial man and much beloved by his confreres and he was for many years in close touch with the large student body.

He was a member of numerous medical societies. In 1874 he was President of the Washtenaw County Medical Society, in 1889 President of the Michigan State Medical Society. He also held a number of appointments as ophthalmologist and otologist to various hospitals in Ann Arbor and Detroit; and, from 1869 to 1871, was an editor of the *Michigan University Medical Journal.*

In 1860 he married Lucy E. Barbour. Of the union were born four children, of whom one, George Edward, Jr., is a well-known ophthalmologist, being ophthalmic surgeon to the Harper Hospital, Detroit, and Clinical Professor of Ophthalmology in the Detroit College of Medicine.

Dr. Frothingham, Sr., died at his home in Detroit, of arterio-sclerosis, April 24, 1900.—(T. H. S.)

Frottement. (F.) Rubbing; friction.

Frottoir. (F.) An instrument used in massage.

Frühjahrskatarrh. (G.) Vernal conjunctivitis.

Fruste. (F.) Abortive, in the sense of incomplete or anomalous.

Frustrané. (F.) Useless; sterile.

Fryer, Blencowe E. An ophthalmologist of the American middle west. He was born in Somerset Co., England, Oct. 26, 1837, the son of an English army officer. He lost his father at a very early age, and, when only seven years old, removed with his widowed mother and five brothers and sisters to America. Here the family settled in Philadelphia, and, in 1859, at the University of Pennsylvania, young Fryer received the degree of Doctor in Medicine. Until the civil war broke out he served as interne in a Philadelphia hospital.

On May 28, 1861, he was appointed Assistant Surgeon in the Union Army, and, from that date till 1887, he was engaged in active U. S. army service. In May, 1887, however, he was ordered before the appropriate board in San Francisco, and was there retired from active service on account of disability.

Doctor Fryer then removed to Kansas City, Mo., where he practised ophthalmology and oto-laryngology exclusively, until about a week before his death.

In 1865 he married Miss Elizabeth Caroline Potter, of Germantown, Pa. Of the union two boys and one girl were born. One of these, Dr. J. S. Fryer, is Surgeon-in-Chief of the National Military Home at Leavenworth, Kansas.

Dr. Fryer was fond of reading and had an excellent library. He is said to have had a remarkable memory, recalling, in fact, the very

pages on which large numbers of articles could be found. On this account he was facetiously termed by a friend "The index catalogue of the Surgeon General's library." His chief amusement was horseback riding—in which he indulged, as a rule, in company with his daughter.

At the time of his death he was Professor of Diseases of the Eye and Ear in the Kansas City Post-Graduate Medical College. He had also held the chair of the same subjects in the old Kansas City Medical College, the University Medical College, and the Medico-Chirurgical College. For more than eight years Dr. Fryer had in charge the

Blencowe E. Fryer.

Department of French Literature in the well-known journal, *Ophthalmology.*

He died in Sault Ste. Marie, U. S. A., Aug. 12, 1911.—(T. H. S.)

Fuchs' coloboma. See page 2355, Vol. IV, of this *Encyclopedia;* as well as **Congenital anomalies.**

Fuchs' disease of the macula. See **Myopia.**

Fuchsin. Rubin. A commercial name for any monacid salt of a rosanilin, especially a mixture of rosanilin hydrochloride and pararosanilin, hydrochloride. It is used in solution in varous liquids as a dye for microscopical sections. Therapeutically, it has been employed in albuminuria, but its remedial value is uncertan. On account of the claim that it corrects defective color-sense when a color-blind person

looks through a fuchsin solution, Delbeuf has suggested its use in such cases. (Foster.)

Fuchs, Leonhart. One of the greatest botanists and general practitioners of medicine of the Renaissance period. He was born Jan. 17, 1501, at Membdingen, Bavaria. In 1519 he entered the University of Ingolstadt, at which institution, after an extremely brilliant career, he received the degree of Master of Arts in 1521. He then pursued the study of medicine in the same institution, and received his professional degree in 1524. For the two years following, he practised medicine in Munich, the next two he passed as Professor of Medicine in Ingolstadt, and then became physician-in-ordinary to the Markgrave George of Brandenburg in Anspach. This position he held for five years. He was ennobled by the Emperor Charles V.

His literary activities began in 1529. Among his numerous writings, we can mention only: "Errata Recentiorum medicorum LX numero, Adjectis eorun conputationibus" (Hagenau, 1530). "Cornarius Furens" (Basel, 1533). "Hippocratis Epidemion Liber Sextus Latinitate Donatus et Luculentissima Commentatione Illustratus" (Basel, 1537). "*Claudii Galeni Aliquot Opera*" (3 vols., Paris, 1549-54).

In 1538 he published an ophthalmologic work, entitled, "*Tabula Oculorum Morbos Comprehendens,*" which seems to be no longer extant. In his "*Institutiones Medica,*" first published in 1556, he exhibits a chapter entitled "Vitiorum Oculi Succincta Explicatio." A work in German, entitled "*Alle Krankheiten der Augen durch den Hochgelehrten Doctor Leonhart Luchsen*" (Strassburg, 1539) is declared by Hirschberg to be nothing but a badly garbled translation of the above-mentioned chapter from the "*Institutiones,*" issued by a trio of quacks—"Herrn Jörgen Vogtherren, Canonicus und Pfarrherren zu Feuchtwangen, und Conradi und Bartholomei Vogtherren"—who had, in fact, altered Fuchs's work to suit their own purposes.

Fuchs himself was a man of high ideals and spotless character.—(T. H. S.)

Fugacious episcleritis. See page 4498, Vol. VI of this *Encyclopedia*.

Fugitive color. As opposed to *fast* color, one that is readily dissipated or faded by exposure to light, heat, water, etc.

Fügung. (G.) Articulation.

Fühlen. (G.) A feeling, sensation.

Fukala's operation. Removal of the lens for the relief of excessive myopia.

Fulgent. Very bright.

Fulgid. Glittering.

Fulguration. Bipolar voltaization. Alto-frequent cytolysis. Alto-frequent scintillation. Effleuvation. Electrocoagulation. These terms have been very loosely applied to several forms of electrical discharges—natural and artificial—and their effects upon living animal tissues.

The *therapeutic use* of high-frequency and other electric currents, as well as their deleterious effects on the human ocular apparatus have already been more or less discussed under **Electrocoagulation**; **Electrodes**; **Dazzling** and **Eclipse amblyopia**; as well as in the sections devoted to **Electricity in ophthalmic surgery** and **Diathermy.** To the foregoing may be added an excellent report on fulguration by W. S. Bainbridge (*Journ. of Advanced Therap.*, Jan., 1913) so far as it *affects cancer* and other neoplasms.

According to de Keating-Hart's method (*Medical Record,* July 6 and 20, 1912) the monoplar long spark of high frequency and high tension acts not upon the neoplasm, but upon the soil on which the neoplasm has developed. Three groups of facts are relied upon by him to establish the premise:

(1) That sparking, even when used with inadequate surgical operation, gives undeniable results, insufficient, perhaps, but already very definite. (2) That the tumor is in no way modified in its appearance or in its vitality, from which one may reasonably conclude that it is not the tumor itself, but the condition of its nutrition—that is to say, the environment in which it develops—that is transformed. (3) That laboratory experiments and clinical observation furnish plausible explanations of the foregoing.

The *production of fulguration sparks* may be accomplished by means of very differently adjusted apparatus. Static electricity and the city current may be utilized, according to the case. The following list comprises the equipment to which de Keating-Hart gives preference: (1) Electric current: city current, dynamos, or accumulators, etc., may be used. (2) A table holding the rheostats, amperemeters, etc. (3) A transformer coil with rapid interrupter, or transformer in the closed magnetic current (alternating eurent). (4) A condenser furnished with a spark gap. (5) Oudin's resonator. (6) A bellows furnished, according to the case, with a foot-pedal or with a tube of carbonic acid, or an electric pump with disinfected air, the latter being used by us. (7) Special electrodes of de Keating-Hart. (8) An operating table of wood or metal. The latter is used at the New York Skin and Cancer Hospital. When a wooden table is employed it must be grounded in order to prevent burning the patient.

The *first step of fulguration* is purely surgical. This depends entirely upon the exigencies of the case, and need not be given detailed consideration here. Fulguration is essentially a method of treatment for operable cancers. The more complete the removal of diseased tissue, the more certain, according to de Keating-Hart, is the freedom from recurrence. The possibility of complete cure and absolute prevention of recurrence is commensurate with the extent to which eradication may be carried. Where only partial removal of diseased tissue is possible the method of fulguration is palliative rather than curative. In these cases thermo-radiotherapy is advocated.

The *electrical technic* is simple in its description and delicate in its application. The general rule laid down by de Keating-Hart is as follows: Spark for a long time, using powerful sparks of high frequency and high tension, applying them to the area from which every macroscopic trace of cancer has been removed. It is, then, under the cancer, and not upon it, that the electrical discharge is applied.

The spark should be white, producing the sensation of a violent shock, its mean length to be from ten to twelve centimeters. An important detail is to utilize the spark at its maximum length. The electrode should be kept in constant motion, and should be regularly passed over the surface being treated. The reason for this is twofold: (1) In order to avoid carbonization of the points at which the sparks strike the tissue; (2) in order to equalize the dosage, save at suspected points where one must work energetically.

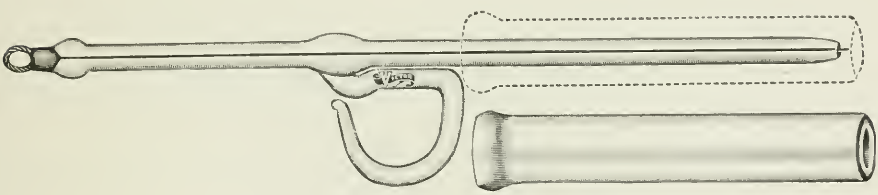
The dosage or the duration of the application of the spark upon the given point cannot be established in other than an empirical manner. It is not difficult to comprehend the reason for this, when one realizes that no two makes of apparatus are exactly alike, and that in the same apparatus there may be great variations in the primary current, the distance of the spark-gap, and the conductibility of the air which surrounds it, all of which bear an influence, as does likewise the insulation of the patient. Under such conditions the electrical properties of the spark are subject to enormous variation. As a general rule, however, one may advise "ten minutes of fulguration for an area of ten square centimeters." This is near enough for ordinary purposes in the majority of cases and with the usual apparatus.

Another guide in the matter of duration is the change in the color of the tissues being fulgurated. All tissues take on a slightly darker tinge, not from destruction, but from the deposit of small blood-clots produced at the surface through contact with the spark. This change of color varies with the tissue involved. While the muscles take on the tinge of smoked meat the bones become slightly yellow. In reality

these appearances are apt to be deceptive, depending upon the manner in which the sparking is carried out, and upon the thickness of the sanguinolent fluid through which it passes. As a rule, bones should not be fulgurated as long as the muscles, or the vessels as long as the tendons.

The two main points to be emphasized are: (1) Sufficient removal of the diseased tissue; (2) powerful sparking of the underlying tissues.

The employment of the high-frequency short spark (from 1 to 4 centimeters), at a relatively low tension, produces the effect of cellular stimulation; it provokes a rapid cicatrization of wounds, and exerts a remarkable action upon torpid ulcers. On the other hand, the high tension spark, of a minimum length of eight centimeters, applied for a sufficiently long period of time in proportion to the surface fulgurated, retards cicatrization and transforms a given area into a torpid wound. The wound fills up, but the surrounding healthy tissue contracts. There is, according to de Keating-Hart, a natural



Simple Fulguration Electrode. (Victor.)

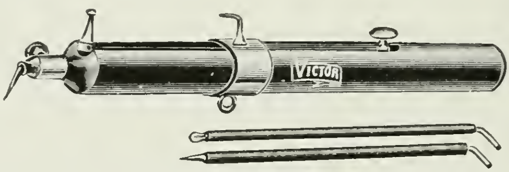
autoplasty, not a cicatrization. He considered that the same trophic phenomenon that prevented the reformation of healthy epidermis after fulguration, retarded or suppressed the propagation of cancer *in situ*. The microscopic cancer cell, not the macroscopic growth, is attacked indirectly and destroyed by this method.

It is claimed by de Keating-Hart that all kinds of cancer have given good results under fulguration. In very advanced cases, he says, important palliative effects, such as the suppression of pain and hemorrhage, cicatrization, increase of strength, prolongation of life, have been noted in more than 70 per cent. of the tumors treated by the method. Cancer of the breast has given him 39.5 per cent. cures. Cancers of the buccal mucosa have given 83 per cent. of freedom from recurrence for periods varying from 7½ months to 2 years. He reports 89 per cent. of successes, for a mean duration of 16 months, in inoperable sarcomas treated by means of fulguration.

Fulguration electrodes for the convenient, local use of high-frequency currents are on the market, two of these being pictured in this

text. According to the vendors, the Victor Electric Co., the simpler device is intended to destroy small growths, such as warts, moles, port-wine marks, vascular nevi and the smaller epitheliomata especially in their incipiency. The electrode is made in two parts, the outer or sheath consisting of a glass tube with ends or lips slightly everted; the inner portion consists of a similar glass tube into which a copper wire has been fused. At the upper end of the inner portion a glass ring is attached, through which the index finger of the right hand is passed while the thumb and middle finger holds the sheath. When the inner portion is plunged at full length into its sheath, a glass collar is so arranged upon the inner portion as to prevent its passage at a point one thirty-second of an inch from the bottom of the outer sheath.

For the removal of a lesion, the outer sheath is placed over the growth, while the inner is drawn upward just beyond sparking distance, about two inches. The end of the copper wire is attached to the high frequency current. When everything is in readiness, suddenly plunge the electrode downward; allow it to remain for from one-quarter to one second, then with the index finger withdraw the inner tube as before. Select a new spot upon the same lesion until the entire surface of the lesion has been covered, when it has a blanched appearance. At least one week should elapse before a second treatment upon the same lesion is deemed necessary.



Improved Fulguration Electrode. (Victor.)

In the *improved electrode* the strength of the convective spark can be controlled with the greatest refinement from a thin mild spark to the heaviest flaming discharge the energizing apparatus is capable of producing.

The controlling is accomplished by varying the distance of a series spark gap on the electrode handle by means of a small button which the operator adjusts with his thumb or finger while the electrode is in operative position. The wider the spark gap the milder the convective spark and vice versa.

The conducting wire from the apparatus is connected to the small eye, which will be noted on the under side of the metal collar in the illustration.

Two metallic points are furnished with each electrode, one bent at an angle of 45 degrees and the other straight.

Fuller's earth. An amorphous, greenish-white, yellow, or brown earth found in layers intercalated between the oolitic and cretaceous strata. It is only partially miscible with water, and easily absorbs fatty substances; hence its use in the cloth industries. It is employed as an absorbent application to irritated surfaces. (Foster.)

Fuller's herb. FULLER'S WEED. SOAP-WORT. *Saponaria officinalis.* According to Pliny and Dioscorides fuller's herb, or soap-wort, was an excellent agent for the clarification of the sight. It formed an ingredient of numerous ophthalmic ointments.—(T. H. S.)

Fulminating. Of diseases, developing suddenly and running on very rapidly to a fatal issue, or to the destruction of an organ or organs.

Fulmine. (It.) A discharge of electricity; the electric shock or spark.

Fulvescent. Approaching a fulvous or yellowish color.

Fulvous. Having a tawny or reddish-yellow color.

Fumée. (F.) Smoke.

Fumitory. *Fumaria officinalis.* One of numerous plant remedies employed by ancient Greco-Roman ophthalmologists (and mentioned by Archigenes, Dioscorides and Pliny) as a preventive of recurrences after epilation. It was also thought to be a sharpener of the sight.—(T. H. S.)

Functionsprüfungen des Auges. (G.) Subjective examination of the eye.

Fundamental ray. The usual optical systems, when the aperture is somewhat large, unite the refracted pencil not into a single point but in a caustic surface, the apex of which is the focus for paraxial rays. The ray which passes through the apex is termed by Gleichen the fundamental ray.

Fundus oculi. The appearance of the bottom or background of the eye (commonly called "the fundus") as discovered by the ophthalmoscope in health and its variations in disease, will be fully described under **Medical ophthalmoscopy.** The minute anatomy of the normal tissues seen in the ocular fundus is described under **Histology of the eye.** Here it may be (briefly) stated regarding the ordinary fundus view that the *optic nerve* is the only one that can be examined during the life of the patient without dissection. By means of the ophthalmoscope the interior of the eye can be studied. The parts of chief interest in the fundus are the optic disc, the blood-vessels, the macula lutea, and the choroid.

The *optic disc* is situated about 3 millimetres to the nasal side of the posterior pole of the eye, and is the point of entry of the optic

nerve into the retina. It is often called the head of the optic nerve. It measures from 1.4 to 1.7 millimetres in diameter and is generally circular or ellipsoidal in shape. In the astigmatic eye the optic disc often appears oval or ellipsoidal when in reality it is round. Owing to the magnification when the ophthalmoscope is used, the papilla appears to be from 9 to 18 millimetres in diameter. Near its centre is a depression, the physiologic excavation, which marks the divergence of nerve-fibres. The excavation is funnel-shaped, the base being anterior. A trace of the hyaloid artery of fetal life is occasionally seen here as a thread of connective tissue running from the papilla into the vitreous. Surrounding the papilla are two rings: an inner, due to exposure of the sclera, is whitish, and is called the scleral ring; and an outer one, due to the showing of choroidal pigment, is named the choroidal ring. At the bottom of the excavation a few dark spots are seen, from the gray stippling of the lamina cribrosa. In color the papilla is grayish-pink or reddish, and stands out in marked contrast to the reddish-yellow of the remaining parts of the fundus. The color of the papilla varies with the age and complexion of the individual, the color of the surrounding parts of the fundus, and with the illumination used. A bluish discoloration of the disc has been observed as a congenital abnormality. A more common anomaly is the presence of opaque nerve-fibres, which condition is due to the fact that the medullary covering of the axis-cylinders exists in the fibre-layer of the retina. In such a case the fundus shows a patch of a brilliant white color extending out from the disc. Generally the white area is in contact with the disc. It rarely occurs that the opaque fibres are found at a great distance from the nerve-head or that they occupy a large area of the fundus. The physiologic cup or depression may occupy a large part of the nerve-head, but never extends to the scleral ring. Under normal conditions many variations are seen in the size and depth of the cup and in the arrangement of the blood-vessels.

The blood-vessels are the central artery and vein. They run in the nerve-fibre layer of the retina, and, although often presenting variations, are of sufficiently regular distribution to justify the naming of the following branches: Superior and inferior nasal, superior and inferior temporal, and macular. The retinal arteries are terminal arteries, each arteriole supplying its own territory without anastomosis. Hence, if a branch is obstructed by an embolus, its territory becomes ischemic and vision is lost. (While this statement is true for almost all cases, in a few instances of embolism of the central artery anastomoses have occurred.) The middle of the fovea centralis has no blood-vessels.

While it is often stated that the retinal vessels can be seen on ophthalmoscopic examination, as a fact it is the column of blood, and not the vessel-wall, which is visible. In the larger retinal vessels the blood-column in the arteries is brighter than that in the veins. In the smaller branches this difference is less marked. The brighter color of the arteries is due to the presence of a central streak of light, which is less marked in the veins. The cause of this light-streak is not definitely known. The retinal arteries never pulsate under normal conditions. (To this statement, which is true for the vast majority of individuals, exceptions must be made, since Jaeger, von Graefe, Donders, and other competent observers, have seen spontaneous arterial pulsation in normal eyes.) The reason for the non-pulsation in the retinal arteries is this: the normal intra-ocular tension is sufficient to overcome the diastole of the heart. Arterial pulsation may be produced easily in the normal eye by pressure on the globe. Whenever a disproportion exists between intra-ocular and intra-arterial pressure, arterial pulsation occurs. Venous pulsation occurs spontaneously in from 60 to 75 per cent. of normal eyes.

Besides the blood-vessels enumerated above, it is necessary to mention the cilio-retinal vessels. These are commonly small, solitary vessels which arise from the circle of Haller, and emerge at the temporal border of the disc. Such a vessel may come from the central vessel in the substance of the nerve, and may be of larger size. Generally it supplies blood to a small area between the disc and macula. Cilio-retinal vessels are present in from 10 to 16 per cent. of normal eyes. Their presence has been known to permit a portion of the retina to retain its functions in cases of embolism of the central retinal artery. Most cilio-retinal vessels are arteries.

Having described the usual arrangement of the blood-vessels, it is necessary to mention some of the unusual appearances found in normal eyes. Twisting of a vein and artery often occurs; but it rarely happens that an artery crosses an artery, or a vein crosses a vein. Anastomoses are very rarely anomalies, and occur on the optic disc. Instances of bifurcating arteries and veins are shown in several ophthalmoscopic atlases. Although the retinal vessels do not pursue a straight course, their tortuosity is subject to much variation. A rare anomaly is the presence of a projecting loop. In Lawford's case a vein formed a loop each end of which disappeared in the disc.

The macula lutea (yellow spot) is situated about 3 millimetres to the outer side of the optic-nerve head, and slightly below the horizontal meridian. It is a spot darker than the surrounding retina and apparently devoid of blood-vessels. It is the area of greatest visual

acuity. The centre of the macula presents the foveal reflex, while the periphery shows a whitish, glistening ring, or halo, known as the macular reflex. It is strange that no two ophthalmic writers agree as to the color and appearance of a part of the retina so accessible to examination as the macula, and that the errors of forty years ago should appear in modern text-books. Many writers have portrayed the macula as oval, with its long diameter placed transversely. Schmidt-Rimpler described it as anatomically circular, but ophthalmoscopically oval. Panas and Mauthner saw it as a brilliantly silvered ring. Power spoke of it as ''a soft, whitish line''; and Landolt described it as ''a bright, oval line, sometimes glistening, with a red floor and intensely red, almost black, centre, the dark point in the centre being hardly ever absent.'' These differences in appearance are doubtless due to several causes: to the difference in methods of examination; to differences in the age, complexion, and refraction of individuals; and to variations in the distribution of pigment. Johnson states that, when observed in a certain way the macular ring in its whole circumference can be seen in every person under thirty-five years of age, and frequently in older subjects. If the illumination is lowered, reflection from the fundus decreases more rapidly than from the macula, until a moment arrives when the ring appears. He asserts that the macular ring is invariably circular, and probably corresponds to the extreme limit of the macular region. When observed as an oval the appearance is due to distortion produced by the lens and mirror. When examined carefully by the direct method of ophthalmoscopy the macula is always round. In elderly persons it can be recognized, although with more difficulty than in the young, by its darker color and by the absence of vessels.

There are several forms of macular rings. Johnson states that the most common is a bright, scintillating reflex resembling shot-silk, very marked in dark eyes, scarcely visible in fair ones, and best seen with feeble illumination. This ring is supposed to be due partly to reflection from Müller's fibres, where they expand into the internal limiting membrane, partly to the fibrous sheaths of the vessels which lift up the retina overlying them. A second form of ring is a radiating circle of grayish-white lustre, the radii being directed toward the fovea and resembling nerve-fibres. The appearance is supposed to be due to a partial translucency of the nerve-fibres. The third form of ring can be seen with the brightest illumination as a whitish or golden ring of metallic lustre, oval in shape by indirect ophthalmoscopy, but circular when seen by the direct method. It is narrower than the other two rings.

Right Eye—Upright Image.

Normal fundus of a young subject.

There is a moderate, or average, amount of pigment. The chorio-capillaris is well-developed. The choroidal arteries, with interspaces of stromal pigment, show faintly near the periphery. The pigment ring of the papilla is complete. The scleral ring is complete, but very narrow. The zone of nerve fibres of the papilla extends almost to the center. The lamina cribrosa is not visible. The thick layer of optic nerve fibres over and near the disc causes a light halo, characterized by radiating striations. The details of the macular region are somewhat idealized, though no single one is more strongly accentuated than it is often found in nature. The idealization is only as regards *ensemble*, and is for greater clearness. From without inward there is first, the ellipsoidal macular halo; next the somewhat densely pigmented area of the fovea, with a few small retinal vessels visible in it. Next, the brink of the foveola, appearing as an indefinite, yellowish circle. Next, the glowing reddish area of the foveola; and, lastly, at the center, the circular reflex from the bottom of the foveola, or fundus reflex of the foveola.—(From Original Drawing by Dr. Chas. H. Beard.)

The foveal reflex is found in the centre of the macula as a very small ring, or as a circular or horseshoe-shaped spot of light, or as a "comet-flare." It is due to reflection of the edge of the fovea.

The choroid. While each ocular tunic contributes something to the ophthalmoscopic picture, the chief part must be credited to the choroid. Light reflected from the mirror of the ophthalmoscope passes through the transparent part of the retina to the pigment epithelium, and is partly absorbed, partly reflected. Although the pigment layer belongs embryologically to the retina, it generally adheres to the retinal surface of the choroid, and is accredited ophthalmoscopically to the latter tunic. The brightness of the fundus picture depends on the amount of pigment. The greater the pigment, the greater the absorption of light and the darker the fundus picture. In the negro and the native of India the fundus is of a brownish, brown-red, or slate color, while in the Anglo-Saxon, and particularly in blondes, it is of a bright-red color. If the pigment layer is very thin, the choroidal vessels are correspondingly exposed and are seen as a network of large, flat vessels, without a light-streak, between which are spaces of light or dark color. They are seen best in albinos. It is generally impossible to differentiate between the choroidal arteries and veins, although at the equatorial region the latter converge to form the venæ vorticosæ. In brunettes the vessels appear as "light streams separated by dark islands," because the spaces are more deeply colored than the vessels.

The sclera, which may be spoken of as the panel on which the fundus picture is painted, is commonly invisible, being covered by the nearly opaque choroid. Yet it is probable that in all eyes some light passes through the choroid, and thus the sclera has some influence on the ophthalmoscopic picture, serving to make it lighter. In albinos the sclera appears as a white surface between the choroidal vessels. It is best seen where the choroid is absent, as in coloboma, or pathologically as a result of destruction of the retina and choroid.—(J. M. B.)

Fundus-reflex test. Skiascopy.

Fungismus. Poisoning by fungi.

Fungus hæmatodes oculi. An ancient name for the third or advanced stage of glioma retinæ.

Fungus medullaris oculi. FUNGUS RETINÆ. (L.) An obsolete synonym for glioma retinæ.

Fungus trichophyton. A vegetable fungus sometimes found on the edges and in the sebaceous follicles of the eyelid.

Funiculus scleræ. In the region of the fovea centralis is found a strand of nerve fibres to which Hannover gave this name. He believed it to

be a scar showing where the choroidal fissure of fetal life had closed up. However, Schwalbe concluded that it is merely a strand of connective tissue that accompanies the posterior ciliary arteries.

Funkensehen. (G.) Colored or scintillating vision. Phosphenes.

Funzione ottica. (It.) Optical function.

Furca. (L.) A fork.

Furca orbitalis. The orbital fork. This is one of the earliest signs of the orbit seen in the embryo, and is simply a trace of bifurcated bony tissue.

Furchenkeratitis. (G.) Mycotic or dendritic keratitis.

Furfurol. One of the poisonous constituents of impure brandy that adds to its evil effects on the ocular tissues.

Furnace-blindness. A name given to that form of dazzling (q. v.) observed in blast and electric furnace workers.

Furnari, Salvatore. Born in Sicily, he received his medical degree at Palermo, and, in 1834, was licensed to practise in France. In 1841 he was sent by the French Government to Algiers on some political mission, during which he made many ophthalmic observations of the native tribes, including the absence of myopia among the Kabyles. In 1848 he returned to Palermo in order to accept the professorship of ophthalmology—a position which he held till his death, in 1866. His only important ophthalmologic writing is "*Essai sur les Causes, la Nature et le Traitement des Ophthalmies en Afrique*" (Paris, 1841). —(T. H. S.)

Furniture, School. See **Conservation of vision.**

Furrow keratitis. One of the many synonyms of dendritic keratitis. See **Keratitis, Mycotic.**

Förster's method. FÖRSTER'S OPERATION. A procedure for the ripening of immature cataract. This operator (*Bericht der Oph. Gesellschaft,* p. 133, 1881) believed that the sudden emptying of the interior chamber and the subsequent rapid change in the shape of the lens would, by a kind of rubbing together of their already partially disorganized fibers, bring about a further opacification of the tissues. He, however, did not rely upon this agent alone but, in his artificial ripening operation, after an iridectomy, firmly stroked the cornea with a strabismus hook for 2 or 3 minutes. There can be no doubt but that this massage of the lens through the cornea is effective in many cases. Förster and others have reported many instances where six or eight weeks after corneal massage the immature cataract was found to be quite ready for extraction.

Furuncle. FURUNCULOSIS IN GENERAL. Although the ophthalmic relations of extraocular furuncle (boil or carbuncle) to the eye struc-

tures are by no means intimate yet occasional examples occur in which the ophthalmologist may be called upon to treat the general disease, which, by the way, is generally a staphylococcus infection. Palpebral furuncle (see **Eyelids, Furuncle of the**) has already been discussed.

Peretz (*Revue Générale d'Ophtal.*, July, 1912) relates the history of a woman, sixty-three years of age, afflicted with diabetes for some time, who, while suffering from a boil on her neck, developed a panophthalmitis. Because of other complications the disease was handled symptomatically for three months. When the author saw the case there was exophthalmus, ectropion and hypertrophy of the lower lids, great sensitiveness and increase of tension to + 3. The neck condition healed. Pain becoming great, exenteration of the globe was performed. Upon incision into the eye pus similar to that from the furuncle welled out. This was a case of metastasis through the blood, and staphylococci were found as in the primary infection.

The *treatment* of furunculosis, both local and general, cannot be fully considered here except to say that furunculosis vaccine (bacterins) has been found of signal value in the disease. Each c. c. of the Parke-Davis product is said to contain killed cultures of staphylococcus aureus obtained from the furuncular lesions (boils or other circumscribed abscesses) of a considerable number of cases. This vaccine is indicated in the treatment of infections from the staphylococcus pyogenes aureus, and is of specific efficiency in the treatment of boils, carbuncles, impetigo contagiosa, pustular acne, and sycosis staphylogenes. The initial dose should not exceed 100 to 150 millions; the second dose, within four days, is 200 to 250 millions; should a third dose be necessary, 300 to 400 millions may be administered four days after the second dose. Subsequent dosage must be governed, as regards both intervals and amounts, by the clinical indications. Furunculosis vaccine is supplied in rubber-stoppered bulbs and in graduated syringes of 400 millions, the bulbs in packages of four, and the syringes in packages of one and four; also in bulk packages of 5 cc. and 20 cc.

Furuncle of the eyelids. See **Eyelids, Furuncle of the.**

Furunculin (zyma). This is a permanent, active, ferment in the form of a white powder. It has proved effective as a disinfectant in internal and external diseases, especially in such affections of the skin as acne, psoriaris, furunculosis, pruritis of the vulva, etc. Internally, it removes dyspeptic disturbances, increases the appetite and regulates the movement of the bowels, with subsequent improvement of the general condition. A. Dutoit (*Archiv f. Augenheilk.*, p. 154, Vol. 74)

corroborates this by his experience with the internal use of furunculin (zyma) in eczematous eye affections. He reports that, externally in the form of a paste or powder, it is well borne by the conjunctiva and cornea. It checks the secretion of the conjunctiva and weakens the virulence of the pathogenic microörganisms in it. It promotes the healing of defects of substance of the lids (ulcerous blepharitis), conjunctiva and cornea (kerato-conjunctivitis, febrile herpes of the cornea). It favors the formation of new corneal tissue and the clearing of corneal opacities from various causes (pannus, keratitis scleroticans). In episcleritis anterior, scleritis and keratitis scleroticans, the internal administration of furunculin (zyma) alone, or in combination with local applications, is of invaluable service in the rapid alleviation of irritation, especially from episcleritic attacks.

Furunculus orientalis. See **Aleppo boil.**

Fuscescent. Approaching to, or tinged with, dark brown.

Fuscin. Retinal melanin. A pigment found as minute granules imbedded in the cell-substance and processes of the retinal epithelium.

Fuscous. Of a dark-brown color.

Fused cylinders. See **Pencils.**

Fusée. (F.) Fistulous tract; fistula.

Fusiform cataract. Coralliform cataract. A synonym of spindle or axial cataract. It is generally congenital, or shows itself early in life, is often hereditary and resembles the lamellar variety. When of the transmitted type it frequently affects successive siblings; more often the first born. Nettleship gives one extraordinary pedigree of five generations containing more than ninety individuals, thirty of whom are known to have had cataract. From the history the cataract must have been congenital in every case and probably due to intra-uterine changes.

Fusion. (G.) A blending of objects, images or sensations. In ophthalmology the term commonly, though not always, refers to binocular vision.

Fusion center. The central neurons presiding over the fusion sense or faculty.

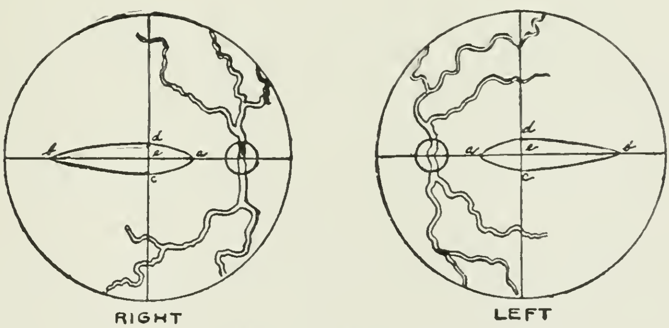
Fusion faculty. Fusion sense. The ability to blend in the brain the two impressions received from the eyes. The practical application of this function to squint will be considered under **Stereoscope.** See, also, **Muscles, Ocular,** and **Fusion field.**

As Worth properly says, the vision of each eye separately, the preponderance of the macular region, and the conjugation of the two eyes in vertical movements, the human infant has fairly well devel-

oped at birth. The conjugation of the eyes for horizontal movements (intended to subserve the function of binocular vision) is perfected within the first few months of life. Between five and six months one finds the first certain evidence of a "desire for binocular vision," though probably a certain degree of binocular vision is present at a much earlier period. At first, if any obstacle be interposed, it is a question whether an effort shall be made to overcome it, or whether the newly acquired art shall be abandoned and the vision of one eye temporarily suppressed. Towards the end of the first year the eyes will make a considerable effort in the interests of binocular vision. If the obstacle prove insuperable the child suffers from diplopia, being no longer able to suppress the vision of one eye.

The results of fusion training in the case of squinters would seem to show that the fusion faculty normally reaches its full development before the end of the sixth year.

Fusion field. According to Savage this is related to the field of rotation but can be determined only by the use of prisms. He does not



Fields of Binocular Fusion.

believe that it is important to measure the extent of the field except in the four cardinal directions, and pictures approximately the shape and size of the fusion field—as shown in the accompanying cuts. When an image is displaced by a prism to any point within the field, while the image in the other eye is on the macula, an effort at fusion will be made, and if the muscle that must respond is sufficiently strong, fusion will at once take place, caused by such rotation as will bring the macula under the displaced image. When the image is thrown, by a stronger prism, entirely outside of the field of fusion, the guiding sensation, which seems to reside in this area only, will not call on any muscle to move the eye for the purpose of fusion. The

nasal limit of this retinal area, as measured by a prism in front of the eye, is 8°; the temporal limit, 25°; the upper limit, 3°; and the lower limit, 3°. The line drawn through these four points marks the entire boundary of the field. This may be considered the normal size of the fusion area. In some cases it may appear to be smaller, while in still other cases it may be larger. (*Ophthalmic Myology,* p. 83.)

Fusion frequency. When a revolving disk carrying alternating sections of black and white is looked at, the sectors, seen separately when the disk revolves slowly, cause a shimmering as the rate of revolution is increased, which gives place to a uniform appearance when the revolutions become sufficiently rapid. The rate of revolution required to produce this uniform appearance gives the fusion frequency. Lohmann (Graefe's *Arch. f. Ophth.*, lxviii, p. 3, 1908) finds this is greater for images falling on the periphery of the retina than near its center, about three-quarters greater for a part of the retina removed 45 degrees from the fixation point. In congenital amblyopia with squint, however, the increase from the center towards the periphery of the retina was very much less. Hessberg (Graefe's *Arch. f. Ophth.,* lxix, let. 2, 1908) studied the fusion frequency in a series of 11 cases exhibiting pathological conditions of the fundus. Comparison of the diseased with the better eye showed, in almost every case, a slightly higher record for the former, and this was the case whether the disk was divided into two parts, one-half white and one-half black, or into sixty-four alternating sectors. Hessberg concludes, however, that for clinical purposes this method of investigation is yet of slight importance. (*Oph. Year-Book,* p. 230, 1909.)

Fusion pictures. These are practically the pictures, diagrams, etc., used in the stereoscope and especially in specially devised instruments for the exercise of binocular vision and the training of the fusion sense or faculty. They will be described under **Stereoscope.**

Fusion, Potential. The fusion of two images perceived simultaneously by both eyes.

Fusion power. The ability to obtain and maintain binocular vision and the fusion of images. Maddox (*Ophthal. Record,* April, 1907) has perfected an instrument which is designed for the measurement and enlargement of the fusion power. It is intended to meet his ideas of a rotating prism suggested by him in his book on prisms in 1889. It consists of a spectacle frame in which two 6° prisms are so mounted that they are simultaneously rotated in opposite directions. It is made available for interpupillary distances of from 50 to 76 mm. One prism is permanently placed in the toothed disc support, while the other may be slipped out and reversed, making

the instrument useful for both horizontal and vertical vergence. See **Prism verger.**

Fusionsbreite. (G.) Amplitude of fusion.

Fusion sense. See **Fusion faculty.**

Fusion tubes. A miniature stereoscope used in cases of concomitant convergent strabismus to test the ability of the eyes to perceive two images simultaneously and to fuse them. See **Amblyoscope.**

Fuzzy image. A picture not in focus.

G

G. Abbreviation of gram.

Gaal, Gustav. A well-known Hungarian physician, who devoted considerable attention to the eye and ear. Born at Eisenstadt, Hungary, in 1818, or 1819, he received his medical degree and practised for a time in that city. In 1848, because of political troubles, he fled from Vienna, where he happened to be at the time, to Hungary. Afterwards he lived in Turkey, where he turned Mohammedan and became a Turkish military surgeon under the name of Veli-Bey. For a time he resided at Sarajevo, Bosnia. He died in 1870.

Among Gaal's writings the only one of ophthalmologic interest is "*Physikalische Diagnostik und derer Anwendung in der Medicin, Chirurgie, Oculistik, etc.*" (Vienna, 1848).—(T. H. S.)

Gabbett's method. A method of detecting tubercle bacilli in cover-glass preparations.

Gabelkrallenpinzette. (G.) Fork-shaped forceps—for use in fixing the eyeball during operation or examination. See **Forceps, Two-tined.**

Gafsa button. One of the numerous names for Aleppo boil.

Gafäss. (G.) A vessel.

Gaillard, Françcis Lucien. A distinguished French surgeon, inventor of the eyelid-suture which bears his name and which is often used today. (See **Gaillard's suture.**) Born in Poitiers, France, in 1805, he received his professional degree at Paris in 1829, presenting as thesis, "Considérations sur l'Utilité et l'Abus des Théories en Médecine, Suivies de Propositions Chirurgicales." He settled for practice in Poitiers and became a distinguished surgeon. He wrote a large number of works of a general, but none of an ophthalmologic, character. He died in January, 1869.—(T. H. S.)

Gaillard's suture. See **Entropion**; p. 4334, Vol. VI, of this *Encyclopedia.*

Galactocataracta. (L.) An old and obsolete name for a milky (Morgagnian) cataract.

Galactometer. CREAMOMETER. LACTOMETER. LACTODENSIMETER. A graduated (per cent.) tube for measuring the proportion of cream in a given quantity of milk.

Galactoscope. An instrument for the optical testing of the constituents, especially the cream, of milk. See **Donné's galactoscope.**

Galactotoxicon. The active agent in poisonous milk.

Galassi pupillary phenomenon. When the orbicularis is energetically contracted and the eye tightly closed there is narrowing of the pupil, which dilates when the eye is opened.

Galbanum. Gum-resin from *Ferula galbaniflua.* It contains a volatile oil, resin and gum, and is commonly used as an antispasmodic, rubefacient and resolvent; dose 5 to 20 grains.

According to Lewin and Guillery (Vol. I, p. 393) ill-defined ocular symptoms (cloudy vision, phosphenes) have resulted from large doses of this remedy.

Gale. (F.) Itch.

Gale, James (1833-1907), English inventor and electrician, born near Plymouth; he lost his sight at seventeen, but was very successful as a medical electrician and inventor. He was founder of the South Devon and Cornwall Institution for the Blind. Gale received probably the largest fee ever known to be paid for medical electrical attendance—viz., $250,000. See J. Plummer's *The Story of a Blind Inventor* (1868).

Galeamaurosis. A name for amaurotic cat's eye—the condition in which there is a light-reflex through the pupil, in suppurative choroiditis.

Galen, Claudius. The greatest physician of all time, except Hippocrates, and the idol of the medical world for more than a thousand years. Galen was born at Pergamos, in Mysia, A. D. 131, and died in 210. His father, Nicon, was an architect. Of him the subject of this sketch speaks with the greatest affection and admiration, but his mother he calls a virago. His father, he says, "Was of surpassing skill in geometry, architecture, astronomy, arithmetic and logic; but was even better known for his justice, modesty and goodness." Because of a dream, the father decided to dedicate his son to medicine.

Galen received his education not only in his native town but also in many other cities—Smyrna, Corinth, a place or two in Palestine, and, of course, in Alexandria. In the school at the last named place he saw a human skeleton, an experience that seems to have made a great impression on him. In 159, being 28 years of age, he returned to his native city of Pergamos, and became a gladiatorial physician. Six years later he went to Rome.

In Rome he met with an accident, almost upon arriving. Going to a wrestling school, or else a school for gladiators, he indulged in a wrestle, and, being heavily thrown, received a dislocation of the shoul-

der. The bone was set, as it seems, by one who happened to be standing near, under, of course, the instructions of the learned patient himself.

Galen, in Rome, soon became the greatest physician of the known world,* although engaged in constant controversy with other members of his profession. He fought especially the sect of the Methodists. Owing to the rancor engendered by his continual professional disputes, he quitted Rome when 37 years of age, went again upon scientific travels, and, finally (as it must have appeared to him) settled in his native Pergamos. It was not quite "finally," however, for, in a very short time, he was summoned back to Rome by the Emperor, Marcus Aurelius, for the purpose of accompanying that philosopher-warrior on a military expedition into Germany. The great physician, however, very conveniently had a dream, which rendered his trip to Germany inauspicious. Later, he was appointed body physician to the Emperor Commodus. Here ends our knowledge of the external life of the great physician, Galen.

As to Galen's personal character, he is said to have been very pompous and overbearing. He was also impetuous and magnetic, capable of making the bitterest enemies and the most profound converts. He—unlike Hippocrates—was extremely talkative and highly circumstantial. Hence he has been declared by some authorities to have been more of a converser, lecturer, and writer than practitioner.

In anatomy Galen was very original, as can easily be imagined from the years which he had devoted to the study of that subject. Most of his anatomical mistakes arose from the fact that his dissections were, for the most part, necessarily confined to the cadavers of animals. People, in those days, possessed a profound respect for the human body—when it was dead. Human osteology, however, Galen knew very thoroughly, because, perhaps, of the human skeleton which he had run across in the school at Alexandria. He described, too, a number of individual muscles and muscular appendages—the platysma myoides, the masticatory muscles, the popliteus, the tendo Achilles. He even described the six extrinsic muscles of the eye, and some of the muscles of the larynx. Altogether, he made a great advance in myology. He mentions with greater or less detail the aorta, the jugular veins, the three coats of the larger arteries, the lachrymal glands, the puncta lachrymalia, and the lachrymal ducts. The heart he did not seem to regard as a muscle, yet he described it much more accurately than any preceding writer. He placed it, wrongly, of

* His fees were, for the times, simply enormous. Thus, for curing the wife of the consul, Boëthius, he received the equivalent of about $1,800.00.

course, in the center of the thorax. Yet he described it as consisting of straight, oblique, and transverse fibres.

In physiology he did not advance far beyond Hippocrates. Like Hippocrates, he believed in the existence of the four elements of matter —earth, air, fire and water—and the primary qualities that belonged to them, dryness, coldness, warmth, and moisture, respectively. As a result of these four primary qualities of matter, there exists in the human body the four so-called "cardinal" humors—mucus, which is moist and cold, and which is secreted by the brain; blood, which is moist and warm, and which is manufactured in the liver; yellow bile, which is dry and warm, and which, like the blood, is formed within the liver; and, finally, black bile, which is dry and cold, and which has its origin in the spleen.

From different sorts of mixtures of the primary qualities resulted the so-called "secondary" qualities. Only the secondary, or mixed, qualities were cognizable by the senses. Thus, for example, the cardinal humors of the body possessed, as we have seen, each one, a mixture of the primary qualities—otherwise they would not have been appreciable by the senses.

He did not advance much beyond his predecessors in the physiology of respiration and circulation. As to respiration, he was a close follower of the school of Pneumatists. Portions of the world-soul are continually being taken *via* the lungs into the heart, and this individual portion of the world-soul thus inspired is the soul of the individual. From this view seems to have come the idea that a child does not possess a soul until it has been born and has received its first breath—a view which prevails in this country among the laity today and which accounts for the great readiness of some persons to consider feticide as a matter of no great importance. By the heart the world-soul, or pneuma, is diffused through the various portions of the body, where, according to the region to which it is sent, it becomes one or another kind of "spirits." While still in the heart and arteries it is called "vital" spirits. In the brain and in the nerves it becomes "animal" spirits. In the liver and the renal veins it became "natural" spirits.

Galen's circulatory physiology was intimately bound up, as we can see already, with his physiology of the respiration. The object of the circulation is, in fact, the distribution through the body of the pneuma which had been in-taken by the heart by the way of the respiration. From the lungs, the air, or at least the pneuma, entered the left side of the heart, and, thence, the arteries. From this point onward his view of the circulation was undoubtedly obscure, even to himself. We

may add, however, that, in his opinion, the food, after undergoing "coction" in the stomach, gets somehow to the liver, where it is converted into blood. Next it goes to the heart. Then it is driven, *via* the pulmonary arteries, to the lungs, with the object of nourishing those viscera, and (now, however, through the veins), to various other portions of the body.

Galen was the first to divide the causes of disease into "predisposing and exciting," and also into "proximate and remote." In general pathology, it is true, he blundered round and round, by reason of his baseless views concerning the primary elements, the primary and secondary qualities, and especially the cardinal humors. Nevertheless, in special pathology, he was far in advance of his time—a fact due, chiefly, to his strict adherence in this field to observation and experiment. He seems to have vivisected and even to have experimented by various other methods systematically, persistently, and thoroughly. Cutting the fifth cervical nerve, he noted the consequent paralysis of the supra- and infra-spinati.

Galen believed devoutly in the efficacy of drugs—as, in fact, the best of physicians have done in all times. His list of remedies, too, was large. He was guilty, however, at times, of ridiculous polypharmacy, and he made the gross mistake of rejecting all metallic remedies. He had, in particular, an abhorrence of mercury.

In surgery he was also at least in the vanguard of his day, if not actually the leader. An expert minor surgeon, he introduced the accipiter, the sling, the spica, and the testudo—all in use to-day.

This second greatest physician of all time was much greater as an ophthalmologist than was his only superior in general medicine, and his forerunner by six or seven hundred years, Hippocrates. His strictly ophthalmologic writings—"*Optics*" and "*Diagnostics of Diseases of the Eye*"—have, most unfortunately, been lost in the stream of time. Putting, however, one thing with another from various portions of extant writings, we get the following mosaic of Galenic ophthalmology. And, first, let us consider *the Galenic ocular anatomy*. The lids of the eye are composed of an outward skin and also of an inner skin, called periosteum (conjunctiva). Between the two lies the tarsus, from which the eye-lashes extend, as well as a fat-containing web, in the interstices of which lie certain fat-producing hydatids, the purpose of which is to keep the edges of the lids well oiled.

The outer portion of the eye itself is composed of a hard, tough membrane which, beginning at the entrance of the optic nerve, runs forward without transparency until it reaches the ring around which all the different humors and membranes of the eye commingle—the

iris. From the iris on, it is thin and transparent. This portion of the tunic is called the keratoidea, and is much more boldly curved than the posterior portion. Behind the pupil lies the *corpus crystallinum.* Between this body and the keratoidea lies a tiny chamber filled with a watery liquid and with pneuma. Beneath this outermost tunic, or membrane, of the eye, is a second, which arises from the *pia mater* of the brain and is very rich in vessels. It enters the eye accompanied by the optic nerve and by an artery and vein. This covering is called the "choroid coat." From the choroid coat extend in a forward direction certain processes [our ciliary processes] and, from this point onward, the chorioidea can be perceived through the transparent portion of the outermost membrane, the keratoidea. In the center of this portion of the chorioidea is an opening, the pupil. The purpose of the pupil is to weaken the light and so to protect the *corpus crystallinum.* In the little space between the pupil and the chorioidea lies a liquid which resembles the white part of an egg, and the object of which is to keep supplied with moisture certain portions of the eye, as well as to stretch the keratoidea sufficiently outward, for, in case the keratoidea is perforated, the liquid, escaping, allows the cornea to become flaccid and wrinkled.

The pupil itself is occupied by pneuma, which arrives in that situation by pressing forward from the brain through the "pore" of the optic nerve. The pneuma serves to keep the pupil open.

The optic nerves arise from the lateral ventricles of the brain, and contain a lengthwise pore, or passage, for the pneuma. The nerves come together before they leave the cerebral cavity, but part again. However, they do not intermingle where they cross, but only lie the one upon the other, so that no communication takes place between them, excepting only between their pores. The place of overlying is called the *chiasma.* From this point on, each nerve is accompanied by a vein and a rather large branch of the *carotis interna* into the very interior of the eye itself.

Inside the eye, the behavior of the optic nerve is vastly different from what we see in the case of any other nerve of the body. It expands into a beautifully curving reticulated structure which corresponds exactly to the globe-like form of the eye, and fits into every part. Now this remarkable network is of use not merely as a circumscribing membrane for the ocular humors, but its most important purpose is to announce in the lateral ventricles of the brain the changes which have been induced in the *corpus crystallinum* by the falling thereupon of the light-rays.

In the deepest portion of the eye, at the hinder part, is a viscous,

glassy-looking humor, which is called the vitreous humor, or hygron-hyaloides. In front of this is a transparent body, or humor, called the crystalline humor. It is something like a sphere in form, but is flattened just a little on its anterior surface. It rests behind in a little socket which exists for the purpose on the anterior aspect of the vitreous humor. It is covered in front by a membrane which is very tough, but also very clear and as delicate as the finest woven spider-web. The *corpus crystallinum* is retained in place by the forward expansion of the optic nerve, which runs as far as the crystalline border.* For plate illustrating *Galenic ocular anatomy* see **History of Ophthalmology.**

Where the different humors and membranes of the eye come all together, the tendinous expansions of the ocular muscles are inserted into the outermost membrane, and of these all are covered by the forward prolongation of the periosteum, or nutrient covering of the bones which constitute the orbit. The muscles are seven in number, two oblique, four straight, and one retractory.† The oblique muscles give to the eye its rotatory movements.

The tear apparatus consists, for the greater part, of an upper and a lower gland, which, through their ducts, pour out the lachrymal secretion on the surface of the eye continually. A certain amount of tears arises also from two canals which are found in the edges of the lids at the nasal corner. These canals serve also to gather up any excess of tears and carry it down to the nose. They are assisted in their work by a small fleshy body (the *caruncula lachrymalis*) which covers a portion of the canals and serves to give to the superabundant lachrymal secretion its appropriate direction.

Not so bad ocular anatomy, everything considered, for the second century A. D. At all events it stood as the final word concerning the structure of the human eye for more than a thousand years.

But Galen's contributions to ophthalmology consisted of more, far more, than merely anatomical (even combined with physiological) observations. Thus, his pathology and his treatment both show a very decided advance as compared with those of any of the earlier writers. And, first, as to Galen's pathology. Numerous *visual hallucinations* are produced not by disease of the eye itself, but by affections of the brain or of the esophageal orifice of the stomach. These are

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* A mistake, of course. Galen is *almost* thinking of what we call the zonula of Zinn. Yet he did not really discover that structure.

† An error due to the fact that Galen, as before stated, dissected, like other anatomists of his time, only the lower animals. Recall in this connection the enthusiasm, above referred to, with which Galen mentions his having once beheld in Alexandria a human skeleton. The muscle referred to really exists in certain animals. See, in this *Encyclopedia*, **Choanoides.**

often to be distinguished from those produced by incipient cataract. Those produced by a commencing cataract seldom affect both eyes simultaneously, or (at a later stage) to the same degree. The reverse is true of the other class of cases. Further, the pupil will, in the course of time, if a cataract (hypochyma) be forming, exhibit the characteristic color changes of that part. Then again, complete remissions of the trouble, at any time, forbid the diagnosis of hypochyma.

The causes of the various symptoms in the eye relate to: I. The essential organ, the crystalline body. II. The brain and the visual nerve (for the visual power proceeds from the brain to the eye by means of the visual nerve). III. All the portions of the eye other than the crystalline body.

I. *Diseases of the crystalline body* correspond to the eight dyscrasiæ. (See, in this *Encyclopedia*, **Hippocrates.**) The structure can also undergo a solution of continuity, and can be dislocated. If it be dislocated to the right or to the left, the evil is but slight; but if it be displaced in an upward or downward direction, there results diplopia.

II. Likewise, the *brain and optic nerve* exhibit diseases, which correspond to the eight dyscrasiæ, and these parts, too, can suffer solutions of continuity.

III. The affections of the various other portions of the eye occur (chiefly) when, either in the pupil or in the space between the pupil and the crystalline body, air or liquid so comports itself as to hinder the perception of objects by the crystalline body. It can also happen when that portion of the keratoidea which lies before the pupil becomes abnormal; and in inflammations of the conjunctiva, in kemosis and in pterygium. It can also occur, again, in consequence either of enlargement, diminution, distortion or rupture of the pupil. Once again, the aqueous humor may be either increased or diminished, as well as thickened and discolored, and so produce disturbances of vision. Thickening of the aqueous produces loss of vision, as well as short-sightedness. If the thickening be complete (as happens in hypochyma or cataract) the vision is completely shut off. If the thickening correspond to a portion of the pupil only, then the patient sees as distinctly as ever before, but not so many things at once, because of the narrowing which has been produced in the cone of visual rays. If tiny, thickened bodies, unconnected with each other, swim round in the aqueous humor, they produce in the patient an optical illusion, as if, in the outer world, gnats or flies were floating. If the aqueous humor has been darkened, then the patient sees as if through fog or smoke. If the aqueous be changed to any other color, then that color seems to be diffused throughout the external world. Among these

eases should be grouped the optical illusions which occur in consequence of a beginning hypochyma, and which have to be distinguished from similar illusions produced by vapors from the stomach.

Finally, the patient may be affected by disturbances of the innervational pneuma. If the pneuma be abundant and clear, like ether, then the subject sees distinctly and into the farthest distance. If it is only scantily present, but pure, he sees nearby exactly, but distant objects not at all. If it be abundant but moist, he sees far but not exactly. If moist and scanty, he sees neither clearly nor far.

Galen's treatment is, as a whole, even more interesting than his pathology.

Falling of the lashes. Persons who lose their eyelashes should be treated with remedies like those employed for the falling of hair from the head. Such remedies, which, as Galen says, "I have already considered in my *Materia Medica,*" should not be allowed to reach the membranes of the eye itself.

Foreign substances should be removed, but nothing which naturally belongs to the eye, and which has simply been corrupted. A *pterygium* is of a nature foreign to the healthy eye. It is, however, not so plainly foreign as a *honey-tumor.* The larger sort of *water blisters* [cystic tumors] are to be treated by operation, the smaller, however, by drying remedies. The *chalazion,* on the other hand, is, in its very nature, an abnormality, and so should be removed.

A *cataract* can, in the beginning, be dispersed, but not later.

Among the oculists of our day, Galen continues, a certain Justus has cured numerous patients of their *hypopion* by shaking their heads He places the patient upright on a chair, grasps the head between his hands, and shakes it till the pus runs down before the eyes. It then remains below because of the heaviness of its substance. On the other hand, a cataract does not remain below [i. e., after it is couched] unless one carefully fastens it down.

However, there are exceptions. A few cataracts are of a more whey-like consistency, and, when these are depressed, at once break up, and, a little later, settle down as a sediment.

When, however, we wish to dissipate pus in an eye, we have to resort chiefly to the collyria containing myrrh. Next in efficiency come those containing frankincense. Galen remarks, in this connection: "Often I have evacuated the pus at once by means of a puncture in the cornea, just a little above its border."

Remedies for *conjunctivitis* must of necessity belong to those of the general class which are used in inflammations everywhere, yet, in addition, they have to be adjusted to the tender condition of the parts.

Astringent remedies must not cauterize, and should be modified with some demulcent liquid, as white of egg, decoction of goat's horn, or milk. The milk should be from a young and healthy woman, and be pressed from the breasts themselves on to the whetstone on which the collyrium is triturated, in order that it may be instilled into the eyes lukewarm. But the milk is only necessary in the case of pains, whether in consequence of the strength of the inflammation or the acridity of the secretion. As a rule, it is enough to employ the white of egg with fitting remedies, in order to cure the ocular inflammations by means of what are called "one-day collyria." Not infrequently these so reduce even the severe forms of ocular inflammations, that, towards evening, the patient may bathe, and, on the following morning, may employ the hard collyrium for a confirmation of the cure. At the first inunction with this remedy, a trace of some sharp, astringent substance should be commingled with it; at the second inunction, a trifle more. The two applications, conjoined with a moderate promenade before the bath, suffice.

The "one-day collyria" (of which a few, especially those which are known as the "barm-colored," contain an abundance of gum acacia, others, however, little or none at all) contain, in addition, partly copper filings, partly a little annealed copper, and many other moderately astringent, ripening and dissipating substances, such as saffron, myrrh, catechu, castorium and frankincense.

After the use of the collyrium, sponge baths should be employed: when the pain is moderate, once or twice a day; when it is severe, three to four times, especially in the long summer days. The bath should be taken in a decoction of melilot and goat's horn.

Ulcers in the eyes require the remedies appropriate for ulcers in any portion of the body, only they should be of the mildest, e. g., flowers of zinc. The pain-relieving juices of various plants, for example, the mandragora, may be included in the prescription with advantage. The chief aim of the treatment is to keep the ulcer clean, for the nature of the parts will of itself fill out the excavation and lead to cicatrization. Ulcers attended by perforation of the cornea and prolapse of the iris, require astringent remedies. In pustules and abscesses of the cornea, dissipating remedies are proper, mixed, for recent cases, with myrrh, frankincense and saffron.

In *pterygium* and *trachoma* the purifying remedies are proper, employed partly in the form of collyria, partly as dry powder.

In severe cases of *trachoma* physicians have, in their perplexity, thought out a singular remedy, namely, having everted the lids, to cleanse them thoroughly and then to scrape them off without the appli-

cation of drugs. A few scrape only superficially with a small sharp spoon against the scalpel and afterwards wipe up with a soft sponge that which flows away, and then adstringe the lids as far as any roughness remains. Others employ, also, the superficially rough skins of certain sea-animals in a manner entirely appropriate for this purpose. "One of my teachers even prepared an eye-pencil of pumice-stone, and having everted the lids, rubbed the roughnesses away from them with this instrument." As a matter of course, a person must pulverize the pumice-stone, and make it into a pencil with tragacanth or gum. When, under the employment of the pencil mentioned, the discharge begins to cease, then we may venture to rub into the lids purifying medicines; but, at first, we should employ only a weak solution, and later, when it is found that the patient bears this well, we should gradually strengthen it.

Despite his many faults, Galen was a great physician and ophthalmologist, and, though not possessed of the marvelous inventive power and the clear, all-seeing eye of Hippocrates, he remained the lord and god of medicine to and through the middle ages. His influence, however, was not entirely without harm. Boerhaave, in fact, observed that "Galen has done more harm than good." But, if so, it was not the great Pergamene's fault, but the vice of those who, century after century, devoid of originative power, must needs follow "authority" in matters medical, as well as in almost every other field of endeavor that was known to man.—(T. H. S.)

Galenical. Pertaining to remedies prepared according to an official formula, especially to the preparation of remedies used for human beings as opposed to veterinary remedies.

Galeocore. (L.) One of the numerous synonyms of cat's-eye amaurosis.

Galeropia, or **Galeropsia.** An abnormally clear and light appearance of objects, due to some perversion of the visual apparatus.

Galezowski's test. GALEZOWSKI'S PRISM. See page 1180, Vol. II, of this *Encyclopedia*.

Galezowski, Xavier. A distinguished and world-renowned Parisian ophthalmologist. He was born at Lipowice, Poland, in 1832, the nephew of a distinguished general surgeon, Severin Galezowski. He began the study of medicine at St. Petersburg, where he received his degree in 1858. He then proceeded to Paris, where, in 1865, he received the *ad eundem* degree. He studied for a time with Trousseau, and was for a brief period Chef-de-Clinique to Desmarres. During the course of a long and active professional life he invented a number of instruments and devised many operations that still bear his name.

He founded the *Recueil d'Ophtalmologie*, and was for a long time its editor. His clinic for many years attracted hundreds of students and was attended by many thousands of devoted and enthusiastic patients. He wrote a large number of articles, which appeared in his own journal as well as in the "*Archives Générales de Médecine*," *Gazette des Hôpitaux*, *Le Mouvement Médical*, *Union Médicale*, *Revue d'Hygiène*, and the *Annales d'Oculistique*.

He died March 22, 1907, at 76 years of age.—(T. H. S.)

Xavier Galezowski.

Galilean telescope. A telescope with a concave lens for its eyepiece.

Galileo Galilei (1564-1642), one of the fathers of experimental science, was born at Pisa, Italy. Entering the University of Pisa in 1581, he was two years later struck with the fact that the oscillations of a pendulum, no matter what their range, seemed to be accomplished in equal times. About this time he invented a hydrostatic balance and wrote a treatise on the specific gravity of solid bodies. These achievements secured him the appointment of professor of mathematics in the University of Pisa, where he propounded the novel theorem, that all falling bodies, great or small, descend with equal velocity, and proved its correctness by several experiments made from the summit of the leaning tower of Pisa. This provoked the enmity of the

Aristotelians, and Galileo resigned his chair at Pisa and retired to Florence in 1591.

In the following year he was nominated to the chair of mathematics in the University of Padua, where his lectures attracted crowds of pupils from all parts of Europe. Here he taught and worked for eighteen years, from 1592 to 1610. Galileo now began a series of astronomical investigations, all of which tended to convince him still more of the correctness of the Copernican heliocentric theory of the heavens. He concluded that the moon, instead of being a self-luminous and perfectly smooth sphere, owed her illumination to reflection, and that she presented an unequal surface, diversified by valleys and mountains. The milky-way he pronounced a track of countless separate stars. Still more important, however, was the series of observations which led to the discovery of the four satellites of Jupiter on the night of January 7, 1610. He also first noticed movable spots on the disc of the sun, from which he inferred the rotation of that orb. In this year he was recalled to Florence by the Grand Duke of Tuscany, who nominated him his philosopher and mathematician extraordinary. At Florence, continuing his astronomical observations, he discovered the triple form of Saturn and the phases of Venus and of Mars.

In 1611 Galileo visited Rome and was received with great distinction, being enrolled a member of the Lincei Academy. Yet the publication, two years later, of his *Dissertation on the Solar Spots,* in which he openly and boldly professed his adhesion to the Copernican view, provoked against him the censure and warning of the ecclesiastical authorities. Galileo, however, promised (Feb. 26, 1616) to obey Pope Paul V's injunction, thenceforward not to "hold, teach or defend" the condemned doctrines. But in 1632, ignoring his pledge, he published the *Dialogo sopra i due massimi Sistemi del Mondo.* Pope Urban VIII was led to believe that Galileo had satirized him in this work. In spite of his seventy years and heavy infirmities, Galileo was summoned before the Inquisition, and after a wearisome trial and incarceration, was condemned to abjure by oath on his knees the truths of his scientific creed. Since the year 1761 a legend has been current to the effect that on concluding his recantation he exclaimed, *sotto voce,* "Epur si muove" (Nevertheless it does move). In his retreat at Arcetri, near Florence, he continued with unflagging ardor his learned researches, even when hearing grew enfeebled and sight was extinguished. Just before he became totally blind, in 1637, he made yet another astronomical discovery, that of the moon's monthly and annual librations.—*(Standard Encyclopedia.)*

Galipot. See **Turpentine.**

Gallanilide. See **Gallanol.**

Gallanol. Gallic acid anilide. Gallinol. Gallanilide. This is a brownish, crystalline powder, slightly soluble in water; more so in ether and alcohol. Experiments have been made with this substance in eye diseases as 5 to 20 per cent. ointments or as a dusting powder with talc, but the outcome has not been satisfactory.

Gall-apples. These were much employed in Greco-Roman times for various diseases of the eyes. Before they were used, they were boiled in vinegar.—(T. H. S.)

Gallemaert's magnetometer. See **Magnetometer, Gallemaert's.**

Gallenfarbstoff. (G.) Biliary coloring matter.

Gallenfett. (G.) Cholesterin.

Gallereux, A. C. Ambroise Martin. Born at Chichée, France, about 1780 he received his medical degree at Paris, and settled at Tonnerre, where he seems to have lived until his death. His exact life dates are not procurable. He wrote: 1. Mém. sur les Soins à Donner aux Personnes qui Ont été Opérées de la Cataracte (Paris, 1816); 2. Avis au Peuple sur la Cataracte (Paris, 1826); 3. Observations Rélatives à Deux Modes d'Altération du Nerf Optique, etc. (in Sédillot's *Rec. Périod. de la Soc. de Méd. de Paris*); 4. Sur l'Application Topique des Dissolutions d'Opium dans les Ophthalmies.—(T. H. S.)

Gallic acid anilide. See **Gallanol.**

Gallicin. Methyl gallate. $C_6H_2COOCH_3$. This proprietary remedy, said to be gallic-acid-methyl-ester (Merck), is a dirty-white crystalline substance made by heating a methylated solution of gallic acid with sulphuric acid.

Its use in ocular therapy is as a dusting powder in many external diseases of the eye, such as the various forms of chronic and sub-acute conjunctivitis, or it may be applied with a camel's-hair pencil to phlyctenules or in superficial ulcer of the cornea.

This is the method advised by the Editor a number of years ago, after the instillation of a couple of drops of holocain (1-5 per cent.) before applying the powder, because it is likely to irritate and cause pain.

Gallinol. See **Gallanol.**

Gall, James. This philanthropist was a printer of Edinburgh, Scotland, who became much interested in devising tangible type for the blind. His enthusiasm lead him to make extravagant claims for his type, which he considered not only the best ever constructed up to that date (1834) but the most perfect that could be made. In a work which he wrote on the education of the blind he insisted that "they (the blind) were able to skim over the letters with great rapidity in read-

ing, and that already the blind were able to feel the letters and could read books printed with the common English size of type." When tests were made it was found that these claims were greatly exaggerated. His published writings, however, did much in drawing attention to the subject. "And, although," he said, "this surpassed all that was formerly hoped for, even this is not to be considered the smallest size which the blind will be able to read. And so plain were the letters to them, that they can read with a stout glove upon the hand, or a piece of linen laid upon the book." A contemporary, Thomas Anderson, Manager of the Asylum for the Blind in Edinburgh, afterward mentioned the fact that Gall was the first in Scotland to call attention to the fact that the blind might be able to read raised print. He said: "In 1831 he published some elementary works in what may perhaps be called the angular roman character—the roman, with all the circles turned into angles. When these books came out, he requested that some of the boys belonging to the Asylum in Edinburgh might be allowed to take lessons from him. This the directors with pleasure immediately granted; and, I think, three if not four of our sharpest youngsters were under his care twice or three times a week. No restriction as to time was laid upon him—he had them quite at his own disposal—and they continued with him for some months. But, even with all Gall's own attention—and, I am sure when I say so, every security is given that all that perseverance, kindness, and ardor in a favorite pursuit could do was done in their case—yet the result was nothing more than their being able to make out letter by letter, and a few short words, some of them hardly that. As to anything like "reading" in the common acceptation of the word, it was out of the question, Mr. Gall himself being the judge." Gall's publications were adopted in the Asylum at Glasgow, but were soon afterward relinquished for roman capitals devised by Fry of London. These received the name of the treasurer of the Asylum, Mr. Alston (q. v.), and took the name of Alston's type. Anderson mentioned the fact, too often forgotten in the types for the blind at the present day, that a type that appears satisfactory to the eyes must therefore be the best for the blind, but this by no means follows, as has been demonstrated later in the universal use of the punctuate form.—(F. P. L.)

Gall of man and animals. The gall of any of the lower animals (excepting only that of the horse) was supposed to be efficacious in almost all the diseases of the eye. Human gall was especially recommended by an oculist named Miletus, but was not so universally

employed. The gall of the horse was supposed to be poisonous; hence it was never used.—(T. H. S.)

Gallotannic acid. See **Tannin.**

Gallstones, Ocular symptoms of. Although it may be rather far-fetched, yet a connection is occasionally shown to exist between the occurrence of gallstones and eye symptoms. One of these is related by Axenfeld (*Archiv f. Ophthalm.*, Vol. 40, No. 3). He gives the history of a woman with gallstones who died from a metastatic endocarditis, meningitis, etc. There was also a metastasis to the left eye, with marked orbital edema, ptosis and proptosis, followed by purulent uveitis and perforation of the globe.

Galvani, Luigi. (1737-98.) This famous anatomist was born at Bologna, Italy, where he studied theology and, subsequently, medicine at the University there and in 1762 was elected professor of anatomy. Galvani owes the wide celebrity attached to his name to his discoveries in animal electricity; and there is evidence that his views were based on experiments patiently conducted for many years before the publication of his *De viribus Electricitatis in Mortu Musculari Commentarius* (1791). He died in Bologna, where his statue was erected in 1879. Most of his writings were published in a quarto edition in 1841-42 by the Academy of Sciences of his native city; but several manuscript treatises by him were discovered there in April, 1889.—*(Standard Encyclopedia.)*

Galvanism. See **Electricity in ophthalmology.**

Galvanocautery. See **Cornea, Serpent ulcer of the**; as well as **Electricity in ophthalmology.**

Galvano-puncture, Haberkamp's. This author (*La Clinique Ophtalmol.*, July 10, 1905) devised an extremely radical procedure for the relief of the agonizing pain of fulminating glaucoma in which enucleation is deemed essential. This operation in the hands of one who is unskilled in the use of the cautery, would be, in Beard's opinion (in which the writer thoroughly concurs), "a delicate undertaking, as overheating of the aqueous, with consequent injury to the iris and the crystalline could easily be brought about."

The method consists in a paracentesis of the anterior chamber by galvano-puncture. As the healing of the wound is slow, a prolongation of the effect from that which would be obtained from an ordinary paracentesis, can be gotten.—(C. A. O.)

Gambasio, Giovanni. A blind Italian sculptor of considerable merit. See **Gonelli.**

Gamete. A germ-cell.

Gamma, Angle. See p. 471, Vol. I of this *Encyclopedia;* also **Physiological optics.**

Ganglion anesthesia. Ciliary ganglion anesthesia. This subject is discussed under **Anesthesia in ophthalmic surgery,** page 436, Vol. I, of this *Encyclopedia.* J. S. Wyler (*Ophthalmic Record,* Vol. 22, p. 302, 1913) has written favorably of it and there is no doubt but that under certain conditions it has an important place in ophthalmic surgery.

Ganglion cells (of the retina). See **Histology of the eye.**

Ganglion, Cervical. See page 4843, Vol. VI, of this *Encyclopedia;* also **Glaucoma,** near the end of the section.

Ganglion ciliare. (L.) Ophthalmic or ciliary ganglion.

Ganglion ciliare accessorium inferius. (L.) An anomalous ganglion connected with the ciliary branches of the ophthalmic nerve.

Ganglion, Ciliary. See **Ganglion, Ophthalmic.**

Ganglion, Gasserian. Semilunar ganglion. Ganglion of Gasser. Sometimes written *Casserian ganglion.* This separate and independent nerve center lies in the fossa on the anterior part of the petrosa near the apex. Its roots join the carotid plexus and fifth nerve, and its fibres are distributed to the ophthalmic, superior and inferior maxillary nerves.

The chief interest to the ophthalmologist of this ganglion is its removal for the relief of trigeminal neuralgia and the subsequent onset of neuroparalytic keratitis (q. v.). For example, S. H. Brown (*American Journ. of Ophthalm.,* March, 1912) describes the condition found in the right eye of a man from whom the right Gasserian ganglion had been removed fourteen years before to cure a tic douloureux. He had been free from tic doloureux since the operation, but had suffered at times from lachrymation, redness and muco-purulent discharge from the eye without any pain. Examination of the right eye showed slight entropion and trichiasis of the lower lid, doubtless due to the contraction of the scar following the sloughing out of the sutures inserted to keep the lids closed. The friction of the lashes of this incurved lid upon the cornea caused no discomfort. There was a slight palpebral and bulbar conjunctivitis, and a considerable pericorneal injection, but the most striking feature was a large, superficial, slightly-elevated nebula which occupied the lower and outer half of the cornea, avoiding the exact center. The scar was rough on its surface and had the appearance of a flake of some kind superimposed on the cornea. Vision was 5/22.5. The tension was normal. The pupil was about 3 mm. in diameter and very slightly active. It showed a tendency to contract in condensed light, with slight oscillatory move-

ments, but would not dilate in the dark. This was doubtless due to iritic adhesions. No view of the fundus could be obtained.

W. B. Weidler (*Medical Record,* Sept. 14, 1912) gives the history of a woman who had the Gasserian ganglion removed, and three days after the operation was unable to open the right eye. This condition gradually improved, but in about five months an ulcer appeared on the cornea. The eye felt dry and the patient said there were no tears in that eye when she cried. A few days later a sore spot appeared on the forehead above the right eye, which became a neurotrophic ulceration of the scalp. There was loss of sensation for touch and pain over the greater part of the right side of the face; sensation for cold and heat was intact. Later on, the lids became swollen and the ptosis was about as at first. There was muco-purulent discharge, injection of the conjunctiva; the ulceration of the cornea involved one-half of its diameter, and extended into the stroma. There were iritis and cyclitis, vision was reduced to counting fingers at one foot, and tension was minus one. Seven months later the acute inflammatory symptoms had all subsided, the right side of the face was more sensitive to pain and touch, the ptosis remained, the iris was atropic, the pupil showed remains of exudate. The injury to the nerves adjacent to the ganglion was the result of an accident, a hook becoming entangled in the sensory nerves during the operation.

In another case the Gasserian ganglion was removed, and the pain thus relieved. About seventeen months after the operation the right eye became painful, the lids swollen, free discharge and injection of the bulbar and tarsal conjunctiva. There was central ulceration of the cornea involving two-thirds of it. Vision was reduced to counting fingers at three feet. There was considerable pain in the eye and temple. Treatment was somewhat similar to that of the previous case, and after five months the woman decided to have the eye enucleated.

Macroscopic section of the eye showed the ulcer to have been about 10 mm. in diameter, involving the corneal epithelium, Bowman's membrane and the substantia propria. Microscopic examination showed the corneal epithelial layer normal and intact around the limbus and for about one-fourth of the corneal diameter, the remainder being greatly changed by the ulceration. In the lamina propria near the corneo-scleral margin, at one side, were several new blood vessels, and also an invasion of leucocytes. The iris tissue showed foci of round cell infiltrations and loss of pigmentary layer around the pupillary edge. The cellular infiltration had extended to the ciliary body. (*Annals of Ophthalmology*, Jan., 1913.)

Ganglion, Lenticular. See **Ganglion, Ophthalmic.**

Ganglion Meckelii. (L.) Meckel's ganglion. A ganglion situated in the spheno-maxillary fossa near the spheno-palatine foramen. It receives the two spheno-palatine branches of the superior maxillary nerve, and sends branches to the periosteum of the orbit, the mucous membrane of the posterior ethmoidal and sphenoidal sinuses [Luschka]. Its branches are the anterior, posterior and external palatine, the upper nasal, and the nasopalatine, vidian and pharyngeal nerves. (Foster.)

Ganglion nervi optici. Layer of ganglion cells of the retina.

Gangrene of the eyelids. See **Eyelids, Gangrene of the.**

Ganglion, Ophthalmic. Lenticular ganglion. Ciliary ganglion. This important organ is a small quadrate body about the size of a pin's head. It is placed at the back part of the orbit internal to the external rectus muscle. It can be found by tracing the branch of the third nerve to the inferior oblique backward, when the ganglion will be seen. See **Ciliary ganglion**; also, for a description of the removal of this nervous center for the relief of glaucoma, see the end of the heading **Glaucoma.**

Gangrene of the lids. See **Eyelids, Gangrene of the.**

Gänsefuss. (G.) Infraorbital plexus.

Ganzbild. (G.) Entire or stereoscopic image—a term applied by Helmholtz to binocular vision, as opposed to single vision or to diplopia.

Gardenia florida. (L.) A plant species found in Japan or China and cultivated in Southern Asia for the sake of its fragrant flowers. The fruits are used in China as a cooling and soothing remedy in phthisis, fever, inflamed eyes, and skin diseases.

Garengot, R. J. Croissant de (1688-1759). A celebrated general surgeon of Paris, who wrote a "*Surgery*" (1720) and a "*Treatise on Instruments*" (1723), both of which were much read for many years. He was one of the first to extract a cataract, having performed this operation soon after its invention by **Daviel.** His writings, however, possess almost no ophthalmologic importance.—(T. H. S.)

Gargarisme. (F.) A gargle.

Garlands of cells. An arrangement of cellular elements, in certain tumors, sarcoma, for example, that suggest the name.

Garlic. *Allium sativum.* According to Pliny, epinyctis, or suke, a kind of ulcer of the cornea, was favorably affected by garlic employed as a poultice. Garlic was also used for excessive secretion from the eye and for ecchymosis, or "black eye;" but, in general, used as a food, it was thought to be detrimental to the vision.—(T. H. S.)

Gas-burners. It is of great [ophthalmic] importance that in the first

place gas-fittings should be adequate to supply the maximum demand for gas; in the second, that the gas should emerge from each burner under a low pressure. There should be a governor for each gas-burner, or for each small group of gas-burners; these are now readily procurable and when they are used a full flame is obtained which is constantly and steadily kept up by a comparatively slow supply of gas; the incandescent particles or heavy heated hydrocarbon vapors upon which luminosity depends are allowed to remain as long as possible in the flame and the gas is thoroughly burned; and air is not swirled into the interior of the flame by the swift current of gas, thus spoiling the luminosity.

Of gas-burners may be mentioned the bats-wing burner with a slit across the head, the fish-tail burner with two holes converging towards one another, the Argand burner with a circle of holes, etc. All such burners are, however, economically inferior to incandescent burners, first invented by Auer von Welsbach, which are Bunsen burners over the flame of which is fitted a mantle consisting of thoria along with a little ceria, emitting a brilliant white light on incandescence.—*(Standard Encyclopedia.)*

Gas-eye. A peculiar disease said to be prevalent among the employes of the gas-pumping stations in the natural gas regions of the United States. The eyes are inflamed, tender, and sensitive to light.

Gas, Illuminating, Oculotoxic symptoms of. These are: diminution of visual acuity, with contraction of the visual field; dilatation of the retinal veins and contraction of the arteries. Persistent bilateral hemianopsia, after recovery, has been recorded. There is sometimes paralysis of the various ocular muscles, extrinsic and intrinsic, accompanied or unaccompanied by exophthalmia. When the recti are paralysed, there is always exophthalmia. See **Legal relations of ophthalmology**, in the middle of the third article: as well as **Toxic amblyopia**.—(T. H. S.)

Gas, Ocular relations of. Apart from oculotoxic symptoms (see **Gas, Illuminating**) set up by certain gases—carbon monoxide, methane, carbon dioxide, formaldehyde, etc.—and the consideration of coal and water gas as illuminants, the employment of air and oxygen in ophthalmic therapy is practically confined to such uses of these agents as are detailed on page 199, Vol. I, of this *Encyclopedia*. See also, **Illumination.**

Gasoline. See **Pétrol.**

Gassendi, Peter (1592-1655). A notable opponent of William Harvey and a celebrated physicist. He was one of the first, but not the very first, to declare the true location of cataract. Concerning this mat-

ter, he says, in his "*System of Physic*" (8, II, p. 371): "To show that the visual power does not go out from the lens requires no other proof, since that distinguished Parisian surgeon has shown that an animal can see without a lens. He has found, that is to say, that a cataract does not consist of a little membrane between the lens and the uvea, which is torn with the needle and sunken into the deeps of the eye; but that the crystalline body itself, which is shriveled up, is torn from the ciliary processes and sunken into the depths." The very first to teach the true doctrine of the nature and location of cataract was Quarré (1643-1650?); the first to confirm that doctrine by actual dissection was Rolfinck, in 1656.—(T. H. S.)

Gasserian ganglion. See **Ganglion, Gasserian.**

Gastropaca pini. The systemic name of a species of caterpillar whose hairs produce *crucismus.* See **Conjunctivitis nodosa.**

Gastrophthalmia. (L.) Ophthalmia supposed to be caused by gastritis.

Gastroscope. An instrument for viewing and investigating the condition of the interior of the stomach. It consists essentially of a tube with an incandescent light and reflecting prisms.

Gastroscopy. Visual examination of the interior of the stomach.

Gataker, Thomas. An English surgeon, of some importance in ophthalmology. The place and date (about 1715) of his birth are not definitely known. He practised in London, was surgeon to St. George's Hospital and to the King of England. He died in 1769.

Gataker wrote, in addition to works of a general character, "*An Account of the Structure of the Eye; with Occasional Remarks on Some Disorders of that Organ*" (London, 1761).—(T. H. S.)

Gâteau. (F.) In surgery, a roll of lint spread over a wound.

Gauge, Strap. A measuring instrument. See **Eyeglasses and spectacles, Mechanical adjustment of.**

Gaule's pits. See **Cornea, Pitting of the.**

Gauss, Theory of. Gaussian points. According to this observer every optic system has six cardinal points; two principal points, two nodal points, one anterior focus and one posterior focus.

Gavarrett, Jules. A celebrated French physicist and physician, of some importance in ophthalmology. The date and place of his birth are unknown. He became a physician at Paris in 1843, and was Inspector General for Medicine, and Professor of Medical Physics in the same city. He died Aug. 31, 1890. Among his writings the following are of interest to ophthalmologists: 1. Des Images par Réflexion et par Réfraction (*Révue des Cours Scientif.*, 1866.) 2. De

l'Astimatisme (in collaboration with Javal, Paris, 1867).—(T. H. S.)

Gayet, Charles Alphonse. A celebrated Lyonese ophthalmologist. Born in 1832, he occupied the chair of ophthalmology at Lyons from its foundation in 1872 until his death. He wrote no books, but contributed many articles to the *Archives d'Ophtalmologie*, invented a corneal microscope and devised a number of operative measures that bear his name. He was a member of the Académie de Médecine, Officier de la Légion d'Honneur. He died as the result of a carriage accident, in 1904.—(T. H. S.)

Gayet's transplantation of cilia. Gayet suggested that a strip of skin removed from the eye, as in the Alt operation for trichiasis (see page 589 of this *Encyclopedia*), might be left attached at the extremity of the wound towards the outer canthus and then transplanted in the groove formed by splitting the lid-margin. See **Cilia, Gayet's transplantation of.**

Gazelle, The. The dung of the gazelle, enclosed in ear wax and swallowed when the moon is new, will, according to Pliny the Elder, protect the person who swallowed it (and the story) from all diseases of the eye. The gazelle was supposed to be immune to ocular affections.—(T. H. S.)

Geach, Francis. A well-known English surgeon of some importance in ophthalmology. Born in 1824, he became physician-in-chief to the Plymouth Hospital, and Fellow of the Royal Society, and died in 1798.

Among his writings the following is of ophthalmologic interest: "*Medical and Chirurgical Observations on Inflammations of the Eyes,*" etc. (London, 1766-68).—(T. H. S.)

Gebiet. (G.) A district; territory; region.

Geburtsfehler. (G.) A congenital defect.

Geburtsverletzungen. (G.) Birth injuries.

Gefässast. (G.) A branch of a vessel.

Gefässbaum. (G.) The aborescent appearance of the blood-vessels when isolated in entirety from the body. The image (shadow) of the retinal blood-vessels of one's own eye, perceived when a concentrated light is directed obliquely into the eye and the source of the light is moved.

Gefässbezirk. (G.) A vascular area.

Gefässbildung. (G.) The formation of vessels.

Gefässe. (G.) Blood-vessels.

Gefässhaut. (G.) Choroid.

Gefässneubildung. (G.) Formation of new vessels.

Gefässunterbindung. (G.) Ligation of a blood-vessel.

Gefässverstopfung. (G.) Obstruction of a vessel.

Gefensterter Staar. (G.) A soft cataract in which the opacity is not continuous or homogeneous, but in which there are patches or islets of clear lens substance.

Gefühl. (G.) Sensation; sense.

Gegenfarben. (G.) Antagonistic colors; contrast-stain.

Gegenmittel. (G.) Antidote.

Gegenseitig. (G.) Reciprocal.

Gehirn. (G.) The brain; encephalon.

Geisoma. Geison. The supercillary ridge of the frontal bone.

Geissler tube. Low vacuum tube, employed in demonstrating fluorescence and phosphorescence phenomena.

Geisteskrankheit. (G.) Mental disease.

Gekreuztes Doppeltsehen. (G.) Crossed diplopia.

Gelähmt. (G.) Paralyzed.

Gelatigenous. Yielding gelatine.

Gelatine. This well-known agent is obtained from the hoofs, horns, bones, etc., of certain animals. It is soluble in boiling water, glycerin and acetic acid, but insoluble in alcohol, ether or cold water. It gradually swells up in the cold water, forming a soft, viscid mass that absorbs from 5 to 10 times its weight of the fluid.

Gelatine is employed occasionally in the dispensing of ointments, and as such is generally mixed with those agents that are not incompatible with the water added to soften it. Such a preparation is Michel's ichthyol ointment.

The chief use to which gelatine is put in the internal treatment of ophthalmic diseases is its exhibition as a blood coagulant (see **Coagulose**). Tubes of sterile, concentrated, saline gelatin solution are prepared for injection into the gluteal muscles as a hemostatic in retinal and choroidal hemorrhages and in ophthalmic aneurism. Each makes a 2 per cent. solution with boiled water of five ounces, constituting one injection at 103° F. Sometimes stronger solutions are employed at a somewhat higher temperature.

Gelatine forms a good vehicle for those alkaloids, such as cocain, atropia, homatropin, hyosein, etc., that are most commonly employed in the treatment of eye diseases and for the determination of the refractive condition. Made up as small, round and thin wafers and placed for protection in glass bottles, they form a convenient and accurate means of applying these powerful agents to the eye. Spread out on a piece of clean paper the tip of a moistened camel hair brush is applied to the center of the disk. It adheres and may then be

placed upon the exposed sclerotic or in the conjunctival sac there to undergo solution and absorption.

Lucien Howe has drawn attention to the fact that in England dextrin is used instead of gelatine in the manufacture of these ophthalmic discs.

Gelatose silver. See **Albargin.**

Gelb. (G.) Yellow.

Gelber Fleck. (G.) Fovea; yellow spot.

Gelbe Salbe. (G.) Pagenstecher's ointment.

Gelbes Jodquecksilber. (G.) Yellow mercury iodide; mercurous iodide.

Gelbfärbung. (G.) Coloration; staining.

Gelbling, Falscher. (G.) The *Cantharellus aurantiacus,* a poisonous mushroom whose ingestion is sometimes a cause of toxic amblyopia.

Gelbsehen. (G.) Yellow vision.

Gelée. (F.) Frost; also, jelly.

Gelenk. (G.) A joint.

Gelenkfügung. (G.) A joint, whether movable or not.

Gelenkrheumatismus. (G.) Articular rheumatism.

Gelöst. (G.) Dissolved.

Gelsemin. A yellow-brown resinoid from *Gelsemium sempervirens,* which in from 1/8 to 2 gr. doses is given in chorea, rheumatism, etc. See **Gelseminin.**

Gelseminin. (*Not gelsemin.*) GELSEMINA. $C_{22}H_{26}N_2O_3$. This alkaloid is obtained from the root of *Gelsemium nitidum vel sempervirens.* It occurs in minute, yellowish-white crystals, odorless but with a bitter taste; very poisonous; slightly soluble in water, very soluble in ether and alcohol. The hydrochloride, as white, granular crystals, is freely soluble in water.

The alkaloid and its salt act as mydriatics and are used for dilating the pupil, in 1 to 500 solutions; the latter may also be had in the form of gelatine disks, gr. 1-500.

Gelsemism. Poisoning from *Gelsemium sempervirens.* In light cases it is marked by vertigo, ptosis, and weakness of the legs; in severe cases by tremor, anesthesia, and dyspnea. See, also, **Toxic amblyopia.**

Gemeiner Stechapfel. (G.) Datura stramonium.

Gemma oculi. (L.) An old term for the crystalline lens.

Gendron, Louis Florentin Deshais. A celebrated French ophthalmologist. Born at Orléans, the nephew of Claude Deshais Gendron, he received his medical degree at Montpelier and settled in Paris. Here, in 1762, he became, at the School of Surgery, Professor and Demonstrator of Ophthalmology. His celebrated text-book, *Traité des Mala-*

dies des Yeux (Paris, 1770) was for more than 30 years an authority at home and abroad. The dates of his birth and death are not known. —(T. H. S.)

Geneigt. (G.) Bent; inclined.

General anesthesia in ophthalmic surgery. See Vol. I, p. 421, of this *Encyclopedia.*

General blood-letting. See **Phlebotomy.**

General diseases and ophthalmology. Systemic conditions in their relations to ocular symptoms. This very extensive and important subject has to a large extent been discussed in this *Encyclopedia.* See, for example, **Anemia**; **Arteriosclerosis**, p. 612, Vol. I; **Diphtheria**, p. 3998, Vol. VI; **Albuminuric retinitis**, p. 212, Vol. I; **Bright's disease, Ocular symptoms of**, p. 1296, Vol. II; **Diabetes, Ocular relations of**, p. 3924, Vol. V; **Exophthalmic goitre**, p. 4805, Vol. VI; **Brain tumor**, p. 1273, Vol. II; **Chlorosis, Ocular symptoms of**, p. 2068, Vol. VIII, as well as such headings as **Cerebrospinal meningitis**, p. 1974, Vol. III; **Gout**; **Syphilis**; **Gonorrhea**; **Toxic amblyopia**; **Focal infections** and **Disseminated sclerosis.**

Under this heading the following additional references (chronologically arranged) are given by observers especially competent to speak.

The essential importance and relations of systemic to ocular diseases have been elsewhere stated by the Editor as follows: Many eye diseases and symptoms are but local expressions of general pathologic processes; hence the need for investigating the general condition of the patient. Search for tubercular, rheumatic, syphilitic, or neurologic manifestations will be in order. The vocation, habits, and diet should be studied. Often laboratory tests, such as examinations of the blood, spinal fluid, feces, spermatic juices and urine will give valuable data. The various reaction tests for syphilis, tuberculosis, gonorrhea, malaria, etc., are often required. As a rule, the reference of the patient to an internist fully alive to the various needs of the ophthalmologist will be the most effective method of dealing with these matters.

Treibilcock (*Pract. Med. Series,* p. 186, 1910) writes upon certain *affections of the uveal tract* in which definite lesions are produced, for which recognized systemic diseases such as syphilis, rheumatism, gout and some of the anemias are responsible. Included with these are nephritis and diabetes, all of which constitute a systemic dyscrasia. He enters a plea for the study of the patient as an individual and to recognize and treat the underlying cause as well as the symptoms manifest in the eye. The importance of an early diagnosis of the

underlying cause and of the prompt, yet frequently inconvenient and wearisome attempt at elimination of the toxins primarily responsible for the onset of the pathologic processes, is duly emphasized. In other words, the treatment of the eye must not consist in the treatment of that organ only, or in the therapy of the symptoms which it manifests. The etiology must be arrived at by a process of exclusion. When syphilis, gonorrhea, tuberculosis and rheumatism or any local focus of pyemia, as disease in the accessory nasal sinuses, or pyorrhea alveolaris may be counted out, one may direct one's attention to faulty metabolism as a cause.

In a number of apparently healthy eyes, Chance (*Ophthalmology,* Vol. VII, p. 227, 1912) has observed fine granules floating in the aqueous humor or resting on the lens capsule. They were not discovered until dilatation of the pupil threw them into relief against the fundus reflex; and they disappeared in a day or two. All the patients had gastro-intestinal intoxication.

Butler (*Ophthalmoscope,* ix, p. 95, 1912) believes that infection with the diphtheria bacillus may cause severe ocular inflammation, which bears no clinical resemblance to the ordinary type of diphtheritic ophthalmia. He reports four cases illustrating this. In one there were general edema of the lids, chemosis, slight proptosis, and swelling over the lachrymal gland. The swelling was incised without showing pus; which appeared four days later, coming from the periosteum of the malar bone. The pus contained Klebs-Loeffler bacilli. The second patient had a whitlow, and some days later conjunctivitis, without the usual characteristics of ocular diphtheria, chemosis, edema, and pustular eczema of the lids. Instead of staphylococci, which were expected, Klebs-Loeffler bacilli were found. In the third and fourth cases severe post-operative infections, without formation of false membrane, were due to the same bacillus.

The eye complications of cerebro-spinal meningitis observed by Anargyros (*Ophthalmology,* Vol. viii, p. 361, 1912) include cases of abducens paralysis and inflammations of the conjunctiva and cornea. Under the serum treatment these inflammations subsided in a few days. Local instillations of the serum also exerted a favorable influence, and Anargyros regards the specific treatment as the most important. He thinks its early, local application may prevent ocular complications.

Anthrax usually kills before secondary complications can arise. Hence the eye is involved chiefly when the primary lesion is situated on the lids. In a few cases, however, secondary extensions have given rise to panophthalmitis, gangrene of the lids and phlebitis involving

the ophthalmic veins. Verderame (*Klin. Monatsbl. f. Augenheilk.*, p. 232, Aug., 1911) reports a case of this kind. The vitreous became filled with pus without involvement of the cornea; and the eyeball subsequently atrophied. There was severe uveitis, secondary uveitis and glaucoma, with perforation of the sclera.

Sidler-Huguenin (*Archiv f. Ophthalm.*, 69, p. 346, 1912) reports fourteen cases of metastatic ophthalmia after gonorrhea, twelve of which were undoubtedly due to the gonococcus. In five of these patients gonococci were found in the blood, and in six pure cultures were obtained from the aqueous humor. There were nine cases of metastatic iridocyclitis, and three of bilateral metastatic conjunctivitis. His proportion is but twelve cases among 65,000 patients, but he believes the percentages would be found much higher if such cases were carefully looked for. Rollet and Aurand (*Révue Générale d'Ophtal.*, 31, p. 97, 1912) have experimented on the rabbit by inoculation with cultures of the gonococcus, or with the gonotoxin. The organism inoculated in the anterior chamber, iris, or vitreous, produced severe plastic iritis, which ran its course to recovery in from three to five weeks. In the choroid the resulting inflammation was less severe, and inoculation of the ciliary body proved negative in two cases. Inoculation of the optic nerve sheath caused optic neuritis, and subsequent atrophy. Introduction of the gonotoxin into the anterior chamber or vitreous produced plastic iritis; and in the optic nerve sheath, an optic neuritis with subsequent retinal degeneration. In the subconjunctival and suprachoroidal spaces it caused no disturbance. They conclude that in the rabbit gonorrheal infection causes a poisoning of the retinal neuro-epithelium.

The possible relationship between cataract and disturbances of internal secretion is considered by Schiötz (*Norsk. Mag. for Laegevid.*, p. 1201, 1913), who recalls that various authors have reported the occurrence of cataract in association with lowered activity of the parathyroid, pancreatic and sexual glands, and that others have noted lens opacities in connection with hypersecretion of those glands whose activity is commonly regarded as balancing that of the first group, namely, the suprarenals, the thyroid and the hypophysis. He presents some figures from a public clinic and a private practice which seem to show a preponderance of cataract in women as compared with men. Poisoning with adrenalin can produce tetany, and this condition is known as a factor in the causation of cataract. Special attention should be paid to the condition of the parathyroid glands at autopsy; and also to the question of the occurrence of cataract with parathyroid insufficiency.

Frank Allport (*Oph. Record*, December, 1912) gives the history of a boy, aged 18, who had always had normal vision in both eyes. Without accident or apparent cause, he noticed dimness and blurring of vision of the right eye. He had no pain but felt indisposed generally and had a temperature of 102° F. and a chill. There was no rise of temperature, but he looked yellowish and his tongue was thickly coated. Vision was 20/200 and tension was normal. Movements of the eye were slightly painful. His nose, throat and accessory sinuses were pronounced normal. His fundus was normal. He had a central scotoma, as shown in the field of vision. A diagnosis of retrobulbar neuritis from intestinal toxemia was made and he was given pilocarpine sweats, diet, bowel flushings, etc.; diagnosis, catarrhal jaundice.

The patient rapidly improved generally and visually, and he left the hospital in about ten days quite well and with a vision of 20/30.

Finally he had vision of 20/20 and a perfect perimeter chart.

This case shows the possibility of an intestinal toxemia affecting the optic nerve and the satisfactory and speedy result of prompt and proper treatment.

De Schweinitz (*Section on Ophth., Seventeenth Internat. Cong. of Med.*, London, Aug. 10, 1913), speaking of the pathogenesis of chronic uveitis, concludes that there is absolutely no proof that any toxic substance elaborated within the tissues in the course of a so-called gastro-intestinal auto-intoxication, has of itself by its toxic properties, produced a uveitis.

While it may be possible that directly or indirectly the relapses and persistence of certain types of uveitis may depend upon the direct or indirect effect of so-called gastro-intestinal intoxications, exactly as the continuance of a central amblyopia has been supposed to depend upon the same cause, there is no proof of this connection.

While indican in the urine, especially in excessive amounts, is a good index of intestinal putrefaction, its absence does not prove that a gastro-intestinal intoxication is not present, and to depend alone upon the presence of this substance for information in these respects is a mistake.

Inasmuch, as intestinal putrefaction certainly depends upon the activity of bacteria upon the food-stuffs in the intestines, there seems good reason to believe that these bacteria, or their toxic products, may be the cause of an inflammation of the uveal tract, exactly as bacteria from other foci of suppuration, have a similar influence. In this sense, therefore, gastro-intestinal intoxications have a right to be included among the etiologic factors of uveitis.

Inasmuch, as acute articular rheumatism (rheumatic fever) is

rarely, if ever, a cause of iridocyclitis (uveitis), and inasmuch, as various types of myalgia (muscular rheumatism) and polyarthritis are in largest measure not strictly rheumatic affections, it seems advisable to discontinue the term "rheumatic" iritis, or iridocyclitis, and to substitute for it some title which does not commit us to an unproven etiologic factor. Thus far, the one suggested by T. Harrison Butler, to-wit, "auto-toxemic iritis," although not a definite one, seems best to fulfil the indications.

Uveitis (iritis and iridocyclitis) occurring in the subjects of various forms of polyarthritis, is doubtless due to the same cause which creates the joint affections; what the cause is thus far has not been discovered. Similar ocular affections in the subjects of various myalgias (muscular rheumatism) should probably be regarded as manifestations of the same infection or toxemia which causes the muscle- and fibrous-tissue pains and lesions; and, although the so-called rheumatic diathesis has been brought forward as an etiologic factor in this disease, in the absence of definite knowledge concerning its pathogenesis, a more explicit statement as to its causation, and therefore as to the causation of the iridocyclitis with which it may be associated, can not be made.

Evidence is lacking that the relationship between gout and various diseases of the uveal tract (uveitis, iridocyclitis) should be abandoned, in that no satisfactory proof has been presented that the same cause which produces the various manifestations of gout, for example, eczema, joint lesions, etc., may not also produce a chemic inflammation of the uveal tract. It is not unlikely that diabetes, but much more rarely, can be accused in the same manner.

There is satisfactory evidence, clinical and bacteriologic, that the majority of cases of uveitis (iridocyclitis) are caused by micro-organisms or their toxins. Potent in this respect (omitting those excluded from this discussion) the gonococcus and the staphylococcus are conspicuous. Other bacterial elements doubtless may play a similar rôle. As Axenfeld has pointed out, it is difficult and often impossible by the ordinary tests to eliminate the influence of tuberculosis.

That the gonococcus is the cause of many cases of iritis and iridocyclitis is unquestioned, and that it is the cause of many cases ordinarily classified as rheumatic, is undoubtedly true; that it may be the cause of chronic insidious uveitis, especially as it occurs in women, has not been definitely proved, but it cannot be entirely excluded from the list of those micro-organisms which are potent factors in this disease.

The primary source of infection from which the staphylococcus proceeds and reaches the uveal tract, there to create an inflammation, in

all probability most frequently, is a chronic septic process in the mouth (pyorrhea alveolaris), in the tonsil, in the naso-pharynx, in the accessory nasal sinuses, in the intestines, in the uterine cavity, in the skin (boils, furuncles, etc.).

It is probable that in most instances the living bacteria reach the uveal tract, and by their presence and their elaborated toxins bring about the various types of inflammation which are classified under the general term uveitis, the process being a non-suppurative one on account of the modification which these bacteria undergo in their passage through the blood-stream.

Although the term inflammation, as ordinarily defined and conceived, comprehends a pathologic condition characterized by the presence of bacteria at the site of activity, there is much evidence to show that lesions possessing all the fundamental characteristics of similar lesions which result from the immediate action of living bacteria, can be brought about by bacterial toxins, and that in these lesions there is nothing to suggest that in the course of their development bacteria were immediately present (Abbott). Therefore, while proof may be lacking that bacterial toxins circulating in the blood are capable of causing localized inflammations of the uvea, proof is equally lacking that such is not the case. Indeed, we are not justified in denying that these toxins have this power, unless we are also willing to reject the theory of specific combining affinities.

As it is possible to speak intelligently of auto-intoxication only when poisons are formed by the tissues of the body itself, that is, within the metabolism, and are not introduced through specific bacterial infections, and as we have no accurate knowledge of these toxins, it would seem wise to discontinue the term "gastro-intestinal auto-intoxication," although freely admitting that gastro-intestinal intoxications of bacterial or parasitic origin are potent sources of infection.

Although indican, when found in excessive amounts in the urine (indicanuria) is an index of intestinal putrefaction, its absence does not prove that a gastro-intestinal intoxication is not present, nor is it proper to depend upon the presence of this substance alone for information in these respects. If after thorough analysis, urobilin, phenol, increase in the percentage of ammonia output, excess of fatty acids, and increase of conjugate sulphates above 200 mgm., etc., are determined, intestinal putrefaction dependent upon the activity of bacteria on the food-stuffs in the intestines has been demonstrated. These analyses do not in any way prove that any toxic substance elaborated in the course of a so-called gastro-intestinal auto-intoxication, that is, a toxin formed within the metabolism, can by its toxic

properties produce a uveitis, but they do prove the bacterial activity to which reference has been made, and indicate a source from which these bacteria or their toxic products may proceed and cause an inflammation of the uveal tract, exactly as bacteria or their toxins from other foci have a similar influence. In this sense, therefore, gastro-intestinal intoxications have a definite right to be included among the etiologic factors of uveitis.

Chronic insidious uveitis, especially as it occurs in women, who are often anemic, is in all probability most frequently excited by bacteria or bacterial toxins which have come from foci of chronic sepsis, particularly in the mouth, the tonsils, the sinuses, the pelvis, and the gastro-intestinal tract.

While indicanuria certainly has not been proved to have the relationship to the development of certain types of chronic and relapsing uveitis (iridocyclitis) that has been given to it by some writers, there is good reason, as Elschnig insists, to study patients with these diseases of the eye from the metabolic standpoint. This study, however, should not be confined to the ordinary tests for indican in the urine, but should include a thorough investigation of the patient's metabolism. It is probable that such studies may eventually lead to the establishment of a definite group of diseases of the uveal tract called into existence by infections of bacterial origin arising in the intestinal tract.

B. T. Lang (*Brit. Med. Jour.*, Feb. 22, 1913) points out that in the majority of cases of scleritis, keratitis, iritis, cyclitis and choroiditis, the cause of the affection is obscure. Excluding physical damage, the chemical effects of bacteria or other toxins are regarded as that cause. Septic foci occur in three situations: along the respirato-alimentary tract; along the genito-urinary tract; on the skin or in a sinus leading from it.

The views of the writer are based upon an analysis of 176 cases. The areas of septic inflammation which give rise most often to eye troubles are those that are subjected to frequent mechanical disturbances such as infections of the gums, which are massaged at each meal, or the male urethra, which is continuously disturbed during micturation.

It is necessary in every case to find out and treat a septic focus to cure the patient. Many cases of iritis and the like recover under the influence of ordinary treatment and the action of drugs, but such cases frequently recur unless the septic focus is treated and cured.

General surgery in its relations to ophthalmology. See **Distant organs, Operations on, for relief of eye symptoms.**

Generative organs, Diseases of. See, in this connection, **Dysmenorrhea**, p. 4106, Vol. VI, also **Climacteric**, p. 2291, Vol. III, of this *Encyclopedia;* as well as **Gonorrhea**; **Lactation**; **Parturition**; **Suppressio mensium**; **Amenorrhea**; **Puberty**; **Masturbation**; **Soft chancre**; also **Copiopia**; **Gestation**; and **Pregnancy**.

Genièvre. (F.) Gin.

Genoform. O—Oxybenzoic-acid-methylene-acetate. $C_{10}H_{10}O_5$. This proprietary remedy is a glycolester resulting from the interaction of acetyl-salicylic acid and formaldehyde, and occurs as a white crystalline powder with a slightly acid taste, soluble with difficulty in cold water; readily soluble in hot water, alcohol or ether. According to the proprietors the product passes the stomach unchanged and is split in the intestines into salicylic acid, acetic acid and formaldehyde. It exerts a decided analgesic influence in various rheumatic and gouty affections. Its antiarthritic properties are dependent upon the liberation of formaldehyde, which, according to the recent investigations of His and Paul, has a tendency to form combinations with the excess uric acid found in the system of the gouty patient; being quite soluble, these urates are readily eliminated from the organism. The preparation is apparently free from all disagreeable after-effects.

Genoform is said to have yielded excellent results in the treatment of gout, rheumatism, sciatica, neuralgia and the various kinds of rheumatoid pains, and has been recommended as a substitute for the salicylates (and similar compounds) in eye diseases.

The dosage is: 5-7½-10 grains, recommended every 3 or 4 hours, administered in powder or tablet form.

Genou. (F.) Knee.

Genre. (F.) Species; kind.

Genscul, Joseph. Inventor of cauterization of the cornea. Born at Lyons, Jan. 8, 1797, he studied at Lyons and Paris, at the latter institution receiving his degree in 1824. Returning to Lyons he became a famous surgeon. According to Gurlt he was a brilliant operator and inventor, having improved the technique of rhinoplasty, cleft-palate, catherization of the nasal canal, cauterization of varices, etc. Two of his most important writings are the following: 1. *Lettre Chirurgicale sur quelques Maladies Graves du Sinus Maxillaires et de l'Os Maxillaire Inférieur* (with folio atlas; Lyons, 1833.) 2. *Sur le Mecanisme de la Vision* (Paris, 1851).—(T. H. S.)

Genth, Carl. A distinguished Dutch, or German, physician, who, in conjunction with Pagenstecher, wrote the "*Atlas der Pathologischen Anatomie des Augapfels.*" The text of this book was translated into

English in 1875 by Sir William Gowers. Genth died in 1904.—(T. H. S.)

Gentian. *Gentiana lutea.* Gentian juice was used by Dioscorides in ocular phlegmon, while both he and Pliny employed it very frequently as an ingredient in ocular ointments.—(T. H. S.)

Lewin and Guillery (*Die Wirkung von Giften auf das Auge*, I, p. 392) says that ingestion of this bitter root has caused amaurosis.

Gentian-violet. PARIS VIOLET. DIRECT VIOLET. DAHLIA. A green powder, soluble in water and alcohol, and used as a dye and in Weigert's stain. This coal-tar product is said by Bock (*Centralbl. f. pkt. Augenheilk.*, p. 105, 1904) to have caused in a workman a purulent conjunctivitis and corneal ulcer. They shortly afterwards became normal.

Geography of ocular affections. DISTRIBUTION OF EYE DISEASES. Although the importance of assigning or of attempting to assign geographic, topographic or ethnologic limits to certain eye diseases, or of estimating the proportion of ocular affections to each country, is considerable, yet the difficulties attendant upon such a survey are often insurmountable because of the paucity or unreliability of statistics. However, the work and writings of such men as Chibret, Hirschberg, Nimier and Swan Burnett are of considerable help in such a study. Moreover, Roure has given us (*Encyclopédie Française d'Ophtalmologie*, Vol. IX, p. 389) an excellent treatise, the French portion of which has been to some extent compiled from answers to numerous *questionaires* on the subject. To this monograph of Dr. Roure the writer is indebted for much of the following information. The reader is also referred to page 1125, Vol. II, of this *Encyclopedia*, where the *distribution*, as well as the *ethnic relations of blindness*, is discussed; also to the caption, **Ethnology of the eye**, in which the racial characters of ophthalmic diseases and anomalies, including ocular anthropology, are treated at some length.

In the following pages the *distribution of particular diseases*, together with a consideration of the influences exerted upon each by race, climate, topography, occupation, etc., are set forth.

Statistics show that diseases of the lids proper are rare in Russia and do not predominate in any particular country. Trichiasis as a result of trachoma is especially pronounced in Egypt and on the Mediterranean coast.

Diseases of the cornea reach their maximum in Spain and Portugal. In the three cities of these countries from which we have statistics, Madrid, Barcelona, and Lisbon, more than 30 per cent. of all eye affections were corneal. In central Europe the frequency is an average

and the minimum is found in southeastern Europe and in Holland, that is, in low and marshy regions. This condition, which at first seems paradoxical, is explained when considering that in these regions conjunctivitis is very frequent and that the predominance of this disease lowers the percentage of all other eye affections.

In Java, according to Steiner, corneal diseases are, as a whole, rather frequent (32 per cent.). What makes the proportion so high is trachoma complications. Aside from this it should be noted that, on the contrary, primary corneal affections, such as phlyctenular keratitis or ophthalmic scrofula, are exceedingly rare. Steiner explains this by the mode of living of the Malayans. Unlike the poor population in European cities, the natives of Java live out-of-doors or in open or poorly-closed huts. We know that such hygienic conditions are most favorable to the prevention of scrofulous corneal affections.

A study of the distribution of conjunctival affections resolves itself in many cases into a study of the distribution of trachoma, since this is the only form of conjunctivitis having an even approximately complete geography.

Conjunctival diseases, considered as a whole, appear to be most frequent in Russia, principally on the border of the Black and Caspian seas. They reach the enormous proportions of 89.4 per cent. at Sebastopol, 53.3 per cent. at Astrakan, and 53.2 per cent. at Odessa. Most severely affected are the low and humid regions, where the poverty of the inhabitants precludes the taking of proper hygienic measures. In the preceding figures trachoma plays a prominent part. According to Steiner the conjunctival diseases among the Malayan population of Java totals 42 per cent., of which 30 per cent. is trachoma. From the investigations of Van Millingen, Chibret and Hirschberg it appears that trachoma thrives equally well in arctic, temperate and tropical climates. The climatic conditions of high altitude are unfavorable to trachoma, especially if accompanied by low temperature and moisture, as in Switzerland. If, on the other hand, the climate is warm and dry, as in Colorado, the altitude does not diminish the frequency of this disease. Heat and sun aid and aggravate the development of trachoma, and patients suffer more in summer than in winter. Attempts have been made to introduce racial differences in connection with the etiology of trachoma. The white and yellow races are most affected, but the black race is by no means immune.

According to Swan Burnett trachoma is a diathesis and race constitutes only a predisposition. In support of this hypothesis it can be noted that the Latin race, particularly in Italy, is the one most affected in Europe, and that the Brazilians, of Latin origin, are more

affected than other Americans. Chibert believes the Celts to be relatively immune. Nevertheless, pure Celts get the disease both in Ireland and in North America. Norway is free from trachoma, but racial characters in no way prevent Norwegians in the United States from becoming affected. The Jews are particularly exposed to this disease. The gypsies, though unclean, are spared, because they do not mix with the fixed inhabitants of any country. There is but very little trachoma among the negroes of the Soudan and the United States because they live apart from the white people; yet trachoma is very frequent among the negroes of Brazil. Therefore, the negro race is by no means immune.

Trachoma is very unevenly distributed over the surface of the globe, but is found almost everywhere. Russia is severely affected. Of 1,000 eye patients there are 96 trachoma patients in Petrograd; 20 to 40 at Moscow; 60 at Restow; 102 at Helsingfors; 114 at Saratow; 116 at Lodz; 124 at Warsaw; 121 at Libau; 146 at Reval; 180 to 350 at Dorpat; 200 at Riga; 150 to 250 at Odessa; 180 at Kasan. In east Germany we find 130 at Posen, 154 at Koenigsberg. The Mediterranean coast is severely affected. In France the inhabitants of the coasts are more trachomatous than those of the interior; especially the inland mountaineers are rarely affected by trachoma. Southern Italy shows a high percentage of trachoma. Of 1,919 eye diseases treated by Stilo d'Ascola, from 1898 to 1904, about 30 per cent. were trachomatous. In Greece the proportion is 29.6 per cent. Trachoma is infrequent in Switzerland except in Fribourg, where it is introduced either by Italian laborers or by students coming from East Prussia. In Bavaria and Württemberg this disease is infrequent and the cases found are isolated and appear to be of exotic origin. On the other hand, it is found quite frequently in Hohenzollern, a country surrounded entirely by Württemberg, whither it was supposedly brought by soldiers from Rhenish or East Prussia. Trachoma is infrequent in Munich, Nuremberg, Brandenbourg, Saxony, Pommerania, Hanover and Mecklenbourg. Africa is particularly affected by trachoma. The percentage is enormous both on the coast, in Sahel and even on the high plateaus of Alfa. The Arabs on the Saharan incline are possibly still more affected, and travelers report that nearly all aged people are blind. In Egypt more than half the native population is contaminated. The frequency is less in other parts inland, and on the Atlantic and Pacific coasts. All of Asia is trachomatic. The disease is common in China and Japan. Hirschberg gives the percentages 20 for Calcutta, 10 for Bombay; Harston reports 70 per cent. in Hongkong, and Steiner has observed 30 per cent. among the Malayans of Java. In

Arabia one-fifth of the natives are reported affected. While infrequent in New York and the greater part of the United States, trachoma is common in Mexico and on LaPlata.

In Cuba 1 per cent. of the eye diseases is trachoma. In a review of the several epidemics and endemic focci of trachoma in the island of Cuba Fernandez (*Ophthalmology*, p. 173, Oct., 1913) gives his experience as government expert during four years. In the province of Pinar del Rio, out of nearly 2,500 school children, he found that 230 had trachoma, more or less typical. In Havana he examined about 3,000 children and some adults and found 700 cases of the disease. At Matanzas out of 750 children examined, 75 cases were found, but many more are present in the province. At Santa Clara he had several small focci to combat, and his colleague and successor, Penichet, found in a small town of less than a thousand inhabitants, over 100 cases of trachoma. At Oriente Province, very large epidemics have occurred.

John Green, Jr. (*Interstate Med. Journ.*, June, 1913) states that it is impossible, at the present time, to arrive at a complete knowledge of the prevalence of trachoma in the United States, for the reason that as yet no general survey of the incidence of this disease has been undertaken. Even if such a general investigation were to be undertaken, it is extremely unlikely that it would yield accurate results. And the prime obstacle in the path of the investigator would be the fact that, with rare exceptions, boards of health, whether town, city or state, have failed to realize that trachoma is a dangerous contagious disease, and hence have not included it in the list of reportable maladies.

Schereschewesky considers that the disease has not yet become general in the United States, though it is rather frequent along the Atlantic seaboard, owing to the great immigration; it is prevalent to a certain degree in the West owing to western migratory movements; in certain areas of southern Illinois and in the mountains of Kentucky and West Virginia it has been endemic for a number of years.

Brown states that in New York City, prior to 1897, trachoma constituted 4 per cent. in over half a million subjects with contagious diseases; three years later (trachoma having, in the meantime, been classified as a "dangerous contagious" disease by the immigration authorities, thus compelling the deportation of aliens so afflicted) only a little over 2 per cent. were seen in 100,000 cases of contagious diseases. Although New York City probably has the greatest number of cases of any one focus, the disease is on the decline when the increase in population is taken into account. The New York Municipal Bureau

of Health recorded something like 10,435 cases of trachoma in 1908, while in 1909 the number reported was 7,090.

Information from Baltimore, Cleveland and Philadelphia indicates that the disease in these cities is on the decline. In Toledo and Akron, Ohio, it is on the increase. In Dayton, Ohio, it is said to be assuming alarming proportions. In Chicago the disease is stationary.

It should be noted that the increase is especially noticeable in smaller towns and cities which do not seem to be able to put in force the procedures that would insure prompt eradication.

The disease is very prevalent in southern Illinois and in northern Arkansas. In Missouri it is estimated that there are not less than 10,000 sufferers. Stucky found it appallingly prevalent in the mountain regions of eastern Kentucky owing to the fact partly, that many of those who need surgical treatment and hospital care have not the financial means to obtain them; the country in which they live contains no institution where they can be cared for without personal expense, and the county treasury contains no funds to provide for even the hospital care elsewhere. The United States Health Service found about 12 per cent. of 4,000 individuals selected at random to be afflicted.

In Oklahoma, White and Treibley found 65 per cent. of the 100,000 Indian population to be sufferers from trachoma. These authors state that the disease is "very prevalent in Illinois, Missouri, Oklahoma, Arkansas and Texas." White found that 48 per cent. of the white children in the Pawnee public schools were afflicted, and his examination in other white schools throughout the state justifies the assertion that from 20 to 40 per cent. of all the white school children of Oklahoma are trachomatous.

Australasia is almost exempt from trachoma.

Mention should also be made of pure *Egyptian ophthalmia*, which, in the opinion of Roure, should not be mistaken for trachoma. The former disease is now thought by some observers to be a conjunctivitis similar to purulent gonococcic ophthalmia. Démétriadès thinks that it is identical therewith, and is carried from one person to another by flies.

In connection with trachoma attention should be called to the black, pigmented spots appearing during this disease on the tarsal conjunctiva of the upper lid. Steiner has observed them in the Malays of Java and in certain Chinese.

Pterygium is most frequent in hot climates. Its development is due to the combined actions of sunlight and of external irritating agencies such as wind, dust and uncleanliness. It is very common in India,

Constantinople and in Spain. In Madeira its frequency is so great that it is considered epidemic. In France it is principally found on the Mediterranean coast.

Cases of xerosis are unusually numerous among the negroes of South Carolina, especially among their children. The white race in this locality is not affected.

In Cuba are regular epidemics of catarrhal conjunctivitis that is often contagious. The infection is spread by small flies called "guasasas." A similar disease exists in Algeria and is caused by the larvæ of *Oestrus ovis.* This fly sometimes deposits its eggs on people's faces and in their eyes. White worms are developed that are the cause of an intense but not dangerous conjunctivitis.

H. Campbell has observed numerous cases of leprosy of the conjunctiva in Singapore, and the tubercular form of this disease also exists in Iceland.

It is interesting to note the exceptional infrequency of vernal conjunctivitis in Russia. Krukow in Moscow reports only 3 cases in 100,000; Nentausen one in 191,000; Bellarminow and Delganow none in 168,618 cases of eye disease.

Race appears to have a certain influence on the development of glaucoma. White people are most affected, but the disease is also found in yellow and black races. In Havana, according to Lopez, glaucoma is found in the proportion of 11 whites to 6 negroes, 1 mulatto and 1 of the yellow race. The Jews are generally recognized as highly predisposed. Among the glaucoma patients of de Wecker's clinic 20 per cent. were Jews. The Latin races come in for a greater proportion than Anglo-Saxons. Thus glaucoma is less frequent in the United States, where the Anglo-Saxon element predominates, than in Havana, where the Spaniards are numerous. There is also less glaucoma in the English colony of Singapore than in Java, although the climate is similar. Climatic conditions appear to have no influence on the frequency of this affection. Small eyes seem to be most exposed. Derby found 1.24 per cent. of glaucoma in America, 4.75 per cent. in Asia. Glaucoma is said to be quite common in Africa. In Europe, Russia is most affected (from 2 to 10 per cent.); Denmark is next (4.5 per cent.), followed by Switzerland (2.6 per cent.) and Spain (2.6 per cent.); France is last. But the question has not been fully investigated and the figures above presented cannot be considered final.

The irregular geographic distribution of diseases of the lens (cataract) teaches us, to begin with, that sun and heat have to be counted as uncertain factors in their causation until more complete informa-

tion is available. The maximum frequency among eye diseases is found in Utrecht (8.3 per cent.), Madrid (11.1 per cent.), Amiens (12.5 per cent.), and Barcelona (11.1 per cent.), that is, in places varying, both in climate and altitude. The minimum proportion is found in Petrograd (3.0 per cent.), Pavia (2.7 per cent.), and Buenos-Aires, localities which also differ from one another in character. Santos Fernandez justly remarks that on the island of Cuba, where the temperature remains constant the year around, no more nor less cataract is found than in other countries, either in Europe or America.

Apart from the rather frequent cases of traumatic cataract among farmers and factory-workers, it must be admitted that geography does not give us much information about the etiology of this affection.

Certain parts of France are noted for traumatic cataract. In Saint-Etienne, a city with vast metal industries, it often happens that glowing steel particles enter the lens. In Ardèche opalescence of the lens is often caused by stings of wasps that live on chestnut trees and attack the chestnut harvesters.

Examination of available statistics teaches that affections of the iris and choroid are much less frequent in eastern and northern Europe (Russia, Prussia, Holland) than anywhere else. These diseases reach their maximum in central Europe (Bavaria, Württemberg) and are found in an average number of cases (that may be regarded as normal) in southern and southwestern Europe (France, Spain). In Amsterdam and Glasgow the proportion is 1.7 per cent.; in Astrakan, Petrograd, Posen, Odessa and Kiew 2 per cent.; in Magdebourg 14.0 per cent.; in Munich 9.2 per cent.; in Bordeaux, Valencia, Amiens, Nantes, Montpellier and Lisbon from 3 to 6 per cent.

The influence of climate upon this group of diseases is felt only in connection with those general diseases of which they are symptoms; that is to say, they are rarely primary diseases, but appear ordinarily as consequences of syphilis, rheumatism or infectious diseases (influenza, etc.). In Singapore, for example, nearly all affections of the iris or the choroid are of syphilitic origin.

Diseases of the sclera are most common in southern Europe. Statistics from Greece, Spain and Portugal show the proportion to be more than 1 per cent., while in Russia, outside of Petrograd, the proportion nowhere exceeds 0.2 per cent.

Anomalies of refraction and accommodation, while frequent in Holland and Germany, are comparatively rare in Spain and Italy. In addition we note that ametropia is more frequent in the United States and Singapore among the Anglo-Saxon-German population than in Cuba, where Spaniards are in the majority, or in Java (yellow race).

From these observations we may conclude that race has a great influence upon the development of these anomalies.

It is now generally conceded that ethnographic variations in the form of the skull correspond to such modifications in the visual apparatus as shape of the eyeball, proportion of its diameter to the depth of orbit, etc. Anomalies of accommodation may therefore be expected to vary ethnographically. Among the Swedes, who have high orbits and large orbital indices, myopia is very rare. With the yellow and black races refraction is oftenest hypermetropic or emmetropic, although there are in China many myopes. According to Callan, myopia is also the exception in the New York negro schools; the greater part of the pupils being hypermetropic. In the schools of Tiflis, frequented by 1,258 Russian, Armenian and Georgian pupils, more cases of myopia are found among the Armenians and Georgians than among the Russians. With the Malay population of Java errors of refraction are the exception. According to Steiner this depends upon the open-air life of the population and because Malay children do not go to school.

The geographical distribution of myopia is better known than that of other refractive errors, principally through the studies of Boudin, Chervin and Nimier. In France there are two areas of maximum myopia, one in the southern and southwestern provinces (714 to 1,477 for each 100,000 inhabitants), the other in the northern and northeastern provinces (590 to 1,056 per 100,000 inhabitants). The least affected regions in France are Brittany, the borders of the Rhine, Provence and Savoy.

In the rest of Europe we find myopia most prevalent in the eastern, central and western regions. In England and Iceland there are but few myopes, in Spain and Italy it is still rarer. In Russia myopia is frequent, reaching 40 per cent. in Petrograd. In Germany we find as high as 50 or 60 per cent. In Asia, China, Japan and Hindoustan are most affected; in Africa, Egypt, Abyssinia, Tunis and Morocco. In America we find 19 per cent. in New York, and 4 per cent in Buenos-Aires. The Germans claim that myopia is in proportion to the instruction of a people and this claim is not entirely without foundation, for we find in the grammar schools one per cent. of myopes, in the high schools 26 per cent., and 59 per cent. in the colleges. Sustained visual effort favors the development of myopia. But above all, the ethnic predisposition should be kept in mind. Pflueger has shown more cases of myopia in the German part of Switzerland than in the French sections, while Eperon and Sulzer found, under like school conditions.

more cases of myopia among the German than among the Latin race pupils in the schools of Lausanne.

The influence of race on myopia becomes still more marked when the hereditary relations of this affection are borne in mind. Parent found that of 330 instances of myopia the disease was hereditary in 216 families, i. e., in 65 per cent. of the cases. For the reasons before mentioned, astigmatism largely depends upon the form of the skull, and therefore on race. In France, England and Germany the vertical meridian has, as a rule, the greatest curvature, while in the Hebrew race it is the horizontal.

Regarding anomalies of accommodation, Campbell Highet states that in Singapore the amplitude diminishes more rapidly than in Europe, not only among natives, but also among Europeans after prolonged residence in the tropics. We have here to do with climatic influences. The high temperature of these countries can and does actually produce an atony of the organism which, among other symptoms, manifests itself by a lowering of the amplitude of accommodation.

Heterophoria and heterotropia are most frequent in Germany. When one remembers the frequency of errors of refraction in that country it is not difficult to find the reason for the numerous cases of divergent and convergent strabismus (3 to 6 per cent.). In Russia, where diseases of refraction are less frequent, we find also fewer cases of strabismus. In Petrograd and the surrounding country the proportion is highest, but reaches only 2.2 per cent. of the total number of eye diseases. In Singapore errors of refraction and accommodation are frequent (48 per cent.), although the proportion of strabismus is but 0.6 per cent. This contradiction is only apparent, since the greater part of the 48 per cent. is associated with anomalies of accommodation probably due, as just explained, to climatic influences. But errors of refraction, not anomalies of accommodation, is the ordinary cause of strabismus; therefore it is not astonishing to find but few cases of strabismus in Singapore.

Diseases affecting the eye-ball and the orbit are irregularly distributed, but appear to be less frequent in central Europe (0 to 2 per cent.) and more frequent in Russia (1 to 4 per cent.) than anywhere else. It is possible to find a plausible reason for this. It is known that, with the exception of tumors of the globe and of the orbit, the greater number of affections of these organs are panophthalmias, which occur as consequences of traumatisms or septic ulcers. For this reason, in countries like Germany and France, where ophthalmic hospitals are close together, such affections are taken care of before

bulbar or orbital complications arise, while in Russia, where the universities are far apart, the ophthalmic surgeon does not generally see such cases until they have reached their last stages.

Diseases of the optic nerve and of the retina are rather infrequent, if we are to trust available statistics, in Russia. The proportion is 0.3 per cent. in Astrakan and Sebastopol and 1.1 per cent. in Petrograd. In western Europe the frequency appears to be greater: 9.7 per cent. in Barcelona, 8.5 per cent. in Valencia, 7.2 per cent. in Paris. They are as a rule dependent on the general health of the patient, and it is for this reason that the geographic situation has a certain influence. For example, in Germany we find quite often a disease that is elsewhere infrequent, namely, sub-retinal cysticercus, which is due to alimentation. This affection, according to Mitwalsky, is infrequent in Bohemia. In Singapore nearly all cases of retinitis are caused by syphilis. In addition, a considerable proportion of neuritis and of optic atrophy is attributed to malaria. In South Carolina retinitis is nearly always of syphilitic origin. In the same locality some cases of albuminuric retinitis are also on record, mostly among negroes. Wenneman announces the existence in the Congo of a special form of ophthalmia said to be very frequent both among the natives and the foreign population. It is a diffuse, unilateral or double chorio-retinitis. Its etiology is unknown, but it has nothing to do with syphilis or malaria. Santos Fernandez contends that in Havana toxic amblyopia is never caused by nicotine, but only by alcohol. He states that the tobacco of Havana does not cause amblyopia! It is more probable, however, that this immunity from tobacco amblyopia is brought about by the formation in the system of certain "stimulines," which according to Metchnikoff are capable of counteracting the effect of a non-microbic poison, generated during several successive generations of people indulging in the poison. In Cuba the white race is the greatest sufferer from toxic amblyopia.

Rivers believes that the natives of Torres Strait and of New Guinea have very imperfect chromatic sense. In northern Queensland the people have only three words to designate colors. On the island, Kiwaï, blue is said to be confounded with black. The negroes on the strait of Torres do not confound red and green, but they are unable to distinguish blue from green. Among the Esquimos, on the contrary, the color sense is highly developed.

No exact information is available regarding the geographic distribution of diseases of the vitreous body. They are infrequent (0.1 to 3.0 per cent.), and, as is well known, do not constitute a morbid entity but, as a rule, are merely a symptom of some general disease.

Diseases of the lachrymal apparatus are most frequent in central Europe, especially in France, where, as a rule, the proportion exceeds 4 per cent. In none of the French cities from which we have statistics is the proportion less than 3.7 per cent. The inhabitants of southern regions also seem to have a pronounced tendency to lachrymal affections. In oriental Europe, in the neighborhood of Ural and in the mountainous region of central Europe, these affections occur with least frequency. This fact appears to indicate that a mountain climate favors the normal function of the lachrymal apparatus.

Steiner (of Java) calls attention to the relative infrequency of diseases of the lachrymal ducts among the Malays in spite of their flat noses. While among us such a nose-form would be indicative of a congenital or an acquired pathologic process, it is, on the contrary, among the Malayans a racial particularity which does not impair the full development of the nose and the tear ducts.—(Erik Fenger.)

Geometrical forms. A term sometimes used to designate a particular test-type.

Geometrical optics. That branch of optics which concerns itself with the laws of the reflection and refraction of light. See **Physiological optics.**

Geoscopic microscope. An instrument for investigating the minute structure of soils.

Geostatics. The statics of rigid bodies.

Gerade. (G.) Direct, straight.

Geradlinig. (G.) Rectilinear.

Geradsicht. (G.) Direct vision.

Geranium mexicanum. (L.) A species of plant life found in Mexico, where its root is employed as an astringent in diarrhea and dysentery and in eye diseases.

Gerardus Cremonensis (1114-1180 A. D.). An esteemed translator into Latin of Avicenna's "*Canon*," as well as of numerous other Arabian writings; also of the works of Galen and Hippocrates. He invented the word *orbita*, whence, of course, has been derived the English "orbit." It should be recalled, in this connection, that Latin medical terms were first employed, at least to any great extent, in the mediæval Latin versions of Arabian medical authors The Arabs themselves, as well as the Romans before them, resorted to the ancient Greek for medical technicalities.—(T. H. S.)

Gerbsäure. (G.) Tannic acid.

Gerdy, Pierre Nicolas. A distinguished French surgeon, inventor of lachrymal rhinotomy (q. v.). Born at Loches, France, May 1, 1797, the son of a peasant, he studied at Paris under great difficulties. In

1825, however, he was appointed hospital surgeon, in 1833 professor of external pathology, and, in 1837, of clinical surgery. He died March 19, 1856. He wrote on numerous subjects: anatomy, physiology, ophthalmology, philosophy, painting and sculpture. His ophthalmologic writings are as follows: 1. Expériences sur la Vision (1840). 2. Recherches sur l'Unité de la Perception Visuelle (1840). 3. Historique sur les Travaux sur la Vision (*Bulletin de l'Acad. de Méd.,* 1840). 4. Remarques sur la Vision des Somnambules. (*Expérience,* 1841; German trans., Quedlinburg, 1842). 5. Sur la Formation d'un Canal Artificiel dans les Cas d'Obliteration du Canal Nasal (*Jour. des Connais. Méd.-Chir.,* 1848).—(T. H. S.)

Gerlier's disease. Vertige paralysant. An affection noticed by Wilbrand and Saenger (*Neurologie des Auges,* Vol. I) affecting some people in the Swiss Canton of Geneva who suffer from the malhygienic practice of sleeping in unventilated stables. The symptoms are recurrent attacks of vertigo, impaired vision, diplopia, ptosis and oculo-muscular pareses. The attacks last ten minutes; during the intervals the patient suffers from exhaustion and a feeling of fullness in the head. A cure follows a change in the method of living.

Germander. *Teucrium chamædris.* The juice of the leaves of this plant, mixed with oil, was used by the ancient Greeks and Romans as a cure for corneal cicatrices.—(T. H. S.)

Germany, Laws of, relating to ophthalmology. See **Legal relations of ophthalmology.**

Gerold, Jacob Hugo. The surname is also written "Gerson." A well-known ophthalmologist of Aken-on-the-Elbe. He was born at Aken Aug. 3, 1814, and twenty-one years thereafter received his professional degree at Berlin. For fourteen years he practised in Agen, then removed to Delitsch, in order to accept an appointment as County Physician. Three years later, however, he returned to Aken, where he continued to reside and to practise until his death, June 29, 1898.

Among his more important writings are the following: 1. De Chymificatione artificiosa (Graduation thesis, 1835). 2. Über Periphakitis (*Casper's Wochenschrift,* 1845). 3. Die Lehre vom Schwarzen Staar und dessen Heilung (Magdeburg, 1846). 4. Be- oder Empfohlener Studien-plan für Mediciner (Magdeburg, 1846). 5. Grundlinien zu einem Lichtmesser behufs der Nachbehandlung des Grauen Staares, u. s. w. (Magdeburg, 1848). 6. Die Nervöse Augenschwäche und ihre Behandlung (Halle, 1860). 7. Ophthalmologische Studien. Der Lichtmesser für Augenkrankenzimmer, u. s. w. (Quedlinburg, 1862). 8. Ophthalmologisch-klinische Studien. Neue Folge. Zur Therapeutischen Würdigung Farbiger Diopter (Giessen, 1867). 9. Die Ophthal-

mologische Physik und ihre Anwendung auf der Praxis (Vienna, 1869; 1870).—(T. H. S.)

Geromorphism. A disease of the skin that occasionally affects the upper lid, producing ptosis. It is characterized by extreme relaxation and flaccidity of the integument in various parts of the body, which assumes a bagginess that gives it, even in young subjects, precisely the appearance of the skin of old subjects.

Gerontopia. An obsolete term for presbyopia.

Gerontotoxon. GERONTOXON CORNEÆ. ARCUS SENILIS. A fatty degeneration of the periphery of the cornea which comes on in old age, affects both eyes simultaneously, and is usually most marked in the upper and lower segments of the cornea. See, also, Vol. I, p. 560, of this *Encyclopedia*.

Gerontoxon. See **Gerontotoxon.**

Gerontoxon lentis. Von Ammon's name for a "crown-like," or bifurcated, sometimes stationary, form of partial senile cataract. The term is sometimes used in the sense of incipient cataract.

Gerson, Georg Hartog. A celebrated German surgeon of some importance in ophthalmology. Born at Hamburg, Germany, Aug. 25, 1788, son of the famous obstetrician, Joseph Gerson, and brother of two physicians, he studied medicine at Berlin and Göttingen, at the latter institution receiving the medical degree in 1810. His dissertation on this occasion was entitled "De Forma Corneæ Oculi Humani deque Singularis Visus Phenomeno," one of the earliest accounts of astigmatism. (See **Thomas Young,** in this *Encyclopedia*.) For a time he served as surgeon in the German army, and was present at Waterloo. In 1816 he settled in Hamburg, and was soon a successful practitioner. He founded in 1819 the "*Hamburg'sches Magazin f. die Ausländische Literatur der Gesammten Heilkunde*," on which he was a collaborator till 1835. In 1833 he was made Professor of Anatomy at the newly constituted Anatomico-Surgical College in Hamburg. After the death of his wife he suffered severely from angina pectoris, and, Dec. 3, 1843, died suddenly of this disease, immediately after he had finished the performance of an enterotomy.—(T. H. S.)

Gerson, Jacob Hugo. A well-known ophthalmologist of Aken-on-the-Elbe. See **Gerold.**

Gerstenkorn. (G.) Chalazion.

Gerstenkorngeschwulst. (G.) Hordeolum or stye; sometimes, also, a chalazion.

Gescheidt, Anton. A distinguished Dresden ophthalmologist. He received his medical degree at Leipzig in 1831, presenting as thesis "De Colobomate Iridis." His most important writings are: 1. Die

Entozoen des Auges. Eine Naturhistorisch-ophthalmo-nosologische Skizze (*von Ammon's Zeitschrift für Ophthalmologie*, 1833). 2. Die Irideremie, das Iridoschisma und die Corectopie, die drei Wesentlichen Bildungsfehler der Iris (von Graefe und von Walther's *Journ.*, 1835). 3. Beiträge zur Pathologie und Therapie der Epidemischen Cholera (Dresden, 1842).—(T. H. S.)

Gerschminkter Staar. (G.) Black or pigmented cataract.

Geschnitten. (G.) Cut.

Geschwulst. (G.) A swelling or tumor.

Geschwür. (G.) Abscess; boil; sore; ulcer.

Gesetz. (G.) Law.

Gesicht. (G.) The sense of sight. The face.

Gesichtlos. (G.) Blind.

Gesichtsachse. (G.) Visual or optical axis.

Gesichtsbetrug. (G.) An optical illusion.

Gesichtsempfindungen. (G.) Phenomena of vision.

Gesichtsermüdung. (G.) Asthenopia.

Gesichtserscheinung. (G.) An optical phenomenon.

Gesichtsfehler. (G.) Defect or dimness of vision.

Gesichtsfeld. (G.) Field of vision.

Gesichtsfeldmesser. (G.) Perimeter.

Gesichtsfeldschema. (G.) Perimeter chart.

Gesichtsfeldstörungen. (G.) Anomalies of the visual field.

Gesichtshügel. (G.) The optic thalamus.

Gesichtsprüfung. (G.) Visual test.

Gesichtsschwindel. (G.) Ocular vertigo.

Gesichtssinn. (G.) The sense of sight.

Gesichtsstörung. (G.) Disturbance of vision.

Gesichtstäuschung. (G.) Optical illusion.

Gesichtsverdunkelung. (G.) Dimness of vision.

Gesichtsvorstellung. (G.) Visual perception.

Gesichtswahrnehmung. (G.) Visual perception.

Gesichtsweite. (G.) The range of vision.

Gesichtswerkzeug. (G.) Visual apparatus.

Gesichtswinkel. (G.) Facial (sometimes visual or optical) angle.

Gestation. Many ocular symptoms are attributed directly to this process, but it is questionable whether the majority have any but an indirect connection with the pregnant state. However, observations of the fields of vision during gestation, made by N. Forti (*Archivio di Ottalmologia*, XVII, 8, abstracted in the *Ophthalmic Review*, p. 240, Aug., 1910), are worthy of consideration. Forti reviews the work of Bellinzona and Tridondani, who had previously made a series of obser-

vations upon the fields of vision in pregnant women. These investigators were careful to choose patients in whom there was no other disturbing cause which might have injuriously affected the accuracy of vision and thus have vitiated their statistics. They believed they were able to establish the following conclusions: That a bilateral limitation of the fields does occur in pregnancy. That this restriction consists, not in a uniform or concentric restriction, but in a bitemporal pseudo-heminanopsia, a limitation of the fields in the temporal area of each. That in nearly every case the field of the left eye was more severely affected than that of the right one. That these alterations are more evident in the primipara than in those who have borne several children, and that they progress as pregnancy proceeds. That there is no tendency to dyschromatopsia or to achromatopsia, the color fields following their usual order of white, blue, red and green. That the accuracy of vision is not in any way interfered with.

The authors also believed that they had been able to establish a relationship between the gravid state and certain visual manifestations which are truly functional rather than the effects of definite pathological alterations, and they support their assertions in part by the observations of one of their number who in the course of investigations regarding certain nerve reactions in pregnancy was struck by the analogy or resemblance between these reactions and those in the condition of hysteria.

Forti repeated the procedure and examined in numerous cases the field of vision in pregnant women whose condition was normal otherwise, and he has arrived at the following conclusions: That there is a very slight limitation to be seen in the nasal half of the field, and a decidedly more definite restriction in the temporal. That as regards right eye and left there is no difference; they are equally affected. That the alteration is more marked in the primipara, but that the advance of pregnancy makes no difference: certainly not for the worse. That the acuteness of vision remains unaffected, and there is normal amplitude of accommodation, but when the patient is compelled to keep the eyes fixed upon an object for a certain space of time very definite hysterical symptoms begin to manifest themselves.

As will thus be seen, Forti is quite unable to confirm the statement of Bellinzona and Tridondani that the left eye is more seriously or more frequently affected than the right; he suggests that possibly the authors have been misled by examining the right eye first as a routine; in the case of any functional defect or lesion such as has been suggested the eye examined after the fatigue of the other would be sure to exhibit the lesion spoken of. The two authors do not say whether

they consistently examined the eye of one side in particular before that of the other, but Forti throws out the suggestion for what it may be worth. The "fatigue-field" would in that event show itself with more constancy in the eye examined later than in the other. He confirmed the truth of this in the cases he examined, for if he took the field of the right eye before that of the left, it, the right, always had the better field, and vice versa.

There is a fairly clear distinction between hysterical restriction of the fields and that seen in the gravid patient in that in the former the limitation is (in the ordinary though not precisely in the etymological sense of the word) concentric, while in the latter the tendency is rather towards hemianopic, or at all events the reduction is more obvious in the two temporal fields than in the two nasal halves, but it is just possible that this apparent difference may be related to the usual custom of examining first the nasal field and then the temporal, in which case the fatigue-symptom of additional limitation would of course appear in the temporal half. This would provide an additional proof of the necessity of examining the fields not in various meridians but in concentric circles. By repeated trials Forti has thoroughly satisfied himself of the fact as stated in regard to the reduction of the field.

With the opinion of Bellinzona and Tridondani that these phenomena are more common in primiparæ Forti is so far in agreement, but he doubts if they are correct in saying that the symptoms increase as pregnancy proceeds; if so, that is rather contrary to the usual course of "sympathetic" reactions in pregnancy. Further, Bellinzona and Tridondani's results as regards the color fields he does not confirm at all; they say that the color fields are restricted in a manner similar to that of the white field, and that neither achromatopsia nor dyschromatopsia occurs among these patients. From this view he dissents altogether, and finds that constantly the color fields are irregularly altered, their boundaries crossing one another, the limits for some color extending beyond those for white, and so on. In short, his results agree with the typical hysterical indications.

Among his patients he did not find any reduction of visual acuteness or any weakness of accommodation, though fatigue on fixation was well marked. See, also, **Pregnancy.**

Gestreifter Staar. (G.) Striated cataract.

Gesund. (G.) Sound; healthy.

Gesundheitspflege. (G.) Hygiene.

Getäfelter Fundus. (G.) Checkerboard eye-ground.

Getreide. (G.) Grain.

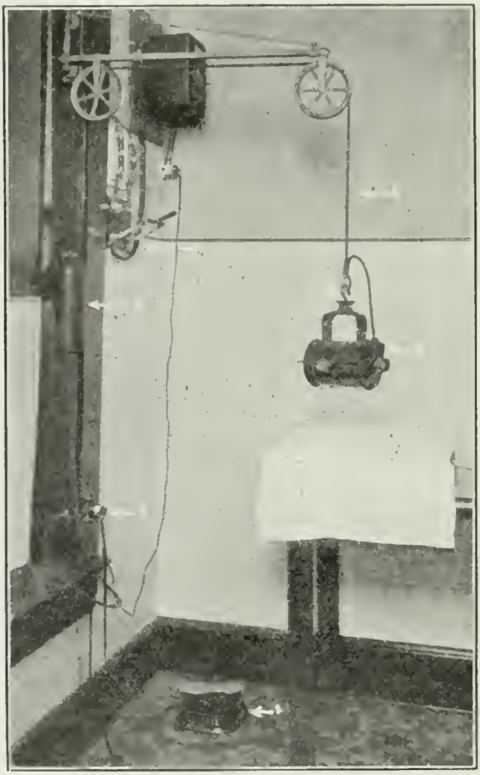
Gewächs. (G.) A growth or excrescence.

Gewebe. (G.) Tissue.

Gewerbserkrankungen. (G.) Occupational diseases.

Giacomi's method. A method of staining the bacillus of syphilis.

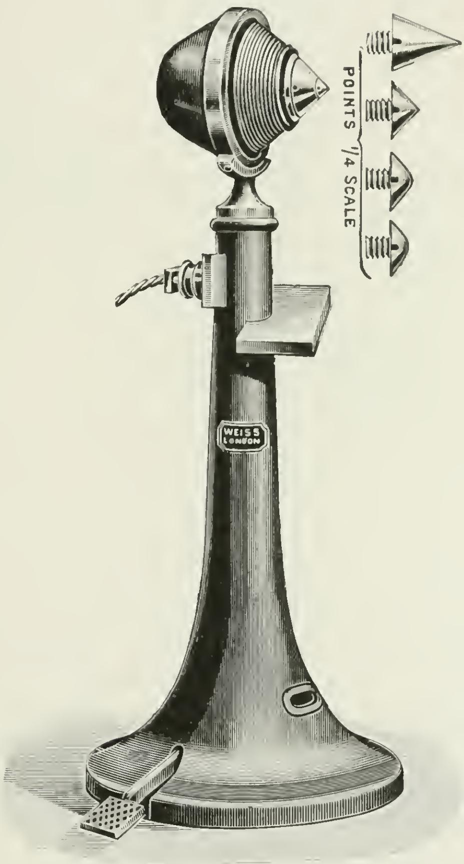
Giant magnet. This important ophthalmic instrument is fully described under **Electromagnet,** on page 4252, Vol. VI, of this *Encyclopedia.* A few cuts of recent or improved magnets are further pictured here.



Device for Suspending the Giant Magnet. (S. J. Forney.)

According to the makers, the Victor (domestic) magnet, mounted on a crane and weighing about sixty pounds, has a lifting power of approximately four hundred pounds to the square inch. It measures ten inches in length from the tip to the rear end and is five and one-half inches in diameter. The crane, although weighing with the magnet considerably more than one hundred pounds, is mounted upon swivelled, light running castors and the entire instrument can be

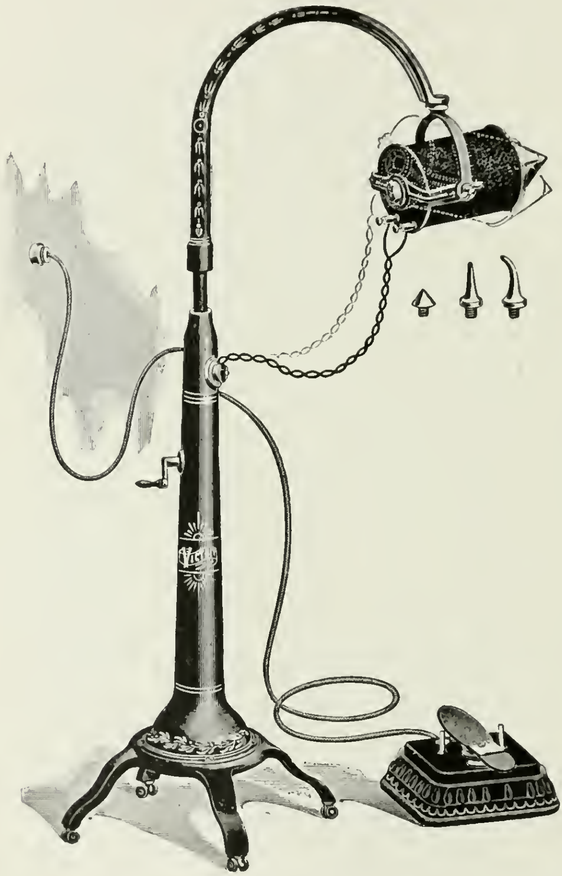
moved without any great effort. The magnet can be raised and lowered easily, quickly and safely by means of a crank and gear arrangement, as shown in the illustration. The magnet is swivelled so that it can be rotated in a complete circle and can be tilted to any angle desired. It is so poised that but little effort is required in adjusting



Haab's Giant Magnet. Improved English Model.

it to the desired position and it can be immovably locked in any position. The chief advantage of this construction is that the patient may be laid on a couch or operating table and the crane moved into such a position that the magnet is suspended directly over him, then by means of the raising and lowering mechanism the magnet may be lowered to the exact position desired; the accidental lowering of the magnet is impossible.

It is best to use a rheostat in connection with the magnet so that its pulling power can be kept under perfect control. This is accomplished best by a Victor rheostat. The foot-controller is used in preference to the one operated by hand, for the reason that the use of the former allows the operator perfect freedom in the use of both his

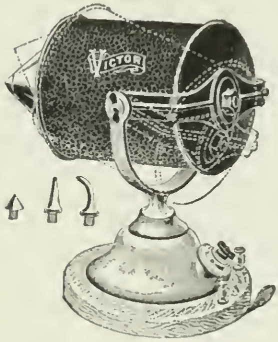


Giant Magnet on a Crane. (Victor.)

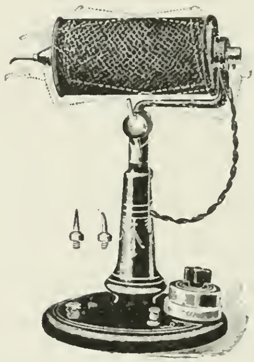
hands, as well as enabling him to concentrate his attention upon the work.

The "Little Giant" magnet has a little over one-fourth the strength of the large Victor giant magnet. It can be raised and lowered, swivelled and tilted. The field strength for a distance of one inch from the point is quite effective, and, although it is not to be compared

with the larger magnet, it is an instrument made for use and is in no sense a toy.



Giant Magnet Mounted on a Base. (Victor.)



Victor Little Giant Magnet.

Giant bipolars. The largest of the bipolar cones of the retina.

Gibbous iris. A name given to a form of posterior synechia when the iris is attached in certain places only so that there appear circumscribed and local bulgings.

Gibril al-Kahhal. This oculist to the Caliph, Al-Mamun, flourished in the 9th century A. D. The following story concerning Gibril is from Usaibia, as repeated by Hirschberg: "Jusuf b. Ibrahim said: Mamun found the hand of the oculist Gibril especially light; never had anyone observed a gentler hand for the eye. He prepared instruments for rubbing up and rubbing in the collyria and collyrium-grinders and presented them to the Caliph. Gibril was the first who came to him after he had said the early prayer and washed his lids and anointed his eyes. This he did again as soon as Mamun had

finished his midday sleep. For this he received 1000 drachma monthly. Later he fell into disfavor. I asked him on what ground. Then he related to me that the chamberlain Husain had become sick and that Jasir, his brother, could not visit him, because of being occupied with his own duties about Mamun's door. Directly Gibril stepped out. Then Jasir asked me concerning the condition of Mamun; I answered that the Caliph slept. Then Jasir seized upon the opportunity and visited his brother. But, before his return, Mamun was awake, and asked for the ground of his absence. Then said Jasir, 'It was told to me that the Ruler of the Faithful was sleeping.' 'Who told thee that?' 'Gibril.' Then Mamun sent for me and said: 'O Gibril! Have I appointed thee to be mine oculist or to be the publisher of news concerning me?' Then I reminded him of my services. He, however, said: 'Verily, he has services. Therefore I shall continue for him his monthly stipend, limited to 150 dirhem. But to the court he will no more be admitted.' " And no more did Gibril serve Mamun until his death.—(T. H. S.)

Gibril b. Ubaid-Allah. A little known physician of Schiraz and Bagdad (born A. D. 920, died 1006), body physician to the Sultan, Professor of Therapeutics and Natural Sciences in the New Bagdad Hospital, and author of numerous works on general medicine. His only ophthalmic writing was "A Circular Letter concerning the Nerves of the Eye."—(T. H. S.)

Gibson, John Mason. An American surgeon, among the earliest of our ophthalmologists. His life-dates are unknown. He became a member of the "Faculty" of Maryland in 1825, and published, in 1832, a book entitled "*Condensation of Matter upon the Anatomy, Surgical Operations and Treatment of Diseases of the Eye*" (published by W. R. Lucas, Baltimore, 1832). This was declared by the author himself to be only a compilation. It was, however, written in a dry and obscure style, which rendered almost valueless its ill-selected and ill-assorted matter. It was, however, the second American work on ophthalmology, and therefore deserves to be mentioned.—(T. H. S.)

Gibson, William. An American surgeon of great skill. He was not only the first in history to tie the common iliac artery in the living human subject, but he is also of special interest in ophthalmology, both because of his ability as an operator on the eye and also because of the claim which has frequently been made for him that he was the first to perform an operation for strabismus. Born in Baltimore in 1788, he received the degree of A. B. at Princeton College in 1806. Deciding to study medicine, he read for a time with Dr. John Owen, of Baltimore, and in 1806 attended certain lectures at the University

of Pennsylvania. For the next three years he studied in Edinburgh, where he received the medical degree in 1809. Proceeding to London, he studied with Astley Cooper, who was very fond of him.

Entering the English army in 1808, he participated in some of the hardest fighting of the Peninsular War, being present, in fact, at the battle of Coruña, where his friend, Sir John Moore, was killed. He was present at the Battle of Waterloo, in which he was slightly wounded. In 1810 he sailed for America.

Settling in his old home, Baltimore, he assisted, in 1811, in founding the Medical Department of the University of Maryland. He himself was professor of surgery in the new school, though only twenty-three years of age. The following year he tied the common iliac artery—the greatest achievement of his life. He resigned his chair at the Baltimore School in 1819, and shortly afterward removed to Philadelphia, where, after the retirement of Philip Syng Physick, he was appointed to the chair of surgery in the University of Pennsylvania. Here for nearly thirty years he taught and practised with great success. In 1855, being sixty-seven years of age, he retired from his teaching position.

Gibson is often declared to have preceded even Dieffenbach in the performance of the cross-eye operation. Thus, Hubbell, in his *Ophthalmology in America*, p. 58, says: "He was the first surgeon to perform the operation for convergent strabismus, which was afterward made so popular by Dieffenbach. Unfortunately, he did not record his operation in time to receive due credit for priority."

Still further, in the same work, i. e., at p. 110, Hubbell continues:

"In times past, as well as today, there have been many evidences of great surgical originality and insight on the part of Americans. In some instances they have been shown by suggestions, in others by demonstrating important procedures and devices. When Dieffenbach's operation, for example, had been made public, it was found that the same operation had long before been suggested and even performed in this country. The great misfortune was that the genius of our American surgeons had not always been put more fully into light and recorded.

"Dr. Ingalls' suggestion of the operation for strabismus was made as early as 1812, as is proved by the following:

" 'Providence, Feb. 8, 1841.

To the Editors of the *Medical Examiner*.

Gentlemen:—I have this day received the following letter from Samuel Y. Atwell, Esq., of this city, in which he gives the credit of

having first suggested the operation for strabismus to Dr. William Ingalls, of Boston.

Mr. Atwell is an eminent member of the legal profession in this state, and his statements are worthy of the highest credit.

I think it due to Dr. Ingalls that the fact of his having first suggested the operation, should be made known to the profession.

I also send you notes of two cases of strabismus on which I have operated successfully. Your obedient servant,

Henry Wheaton Rivers, M. D.'

"'Providence, Feb. 8, 1841.

Dear Sir:—I observe from the newspapers that you have operated with great success in several cases of strabismus, or squinting. I have also noticed this operation spoken of as a new discovery in the art of surgery, and is said to have lately originated in Germany. Now, sir, I think we should give honor where honor is due. In the years 1812 and '13 I attended courses of surgical and anatomic lectures delivered before the Medical School of Brown University, by William Ingalls, M. D., of Boston, then the professor of anatomy and surgery in that institution; being subject myself to this infirmity (strabismus), Dr. Ingalls took frequent opportunities to explain to me the method of its surgical cure; he did this by dissecting the eye itself, explaining the power and disposition of several muscles appertaining to that organ, and showed me how by division of one or more of them, the eye might be brought to its proper place. In my own case I know he proposed to divide the *rectus internus*. So strongly was I impressed with the practicability and success of this operation, that I strongly urged my father to permit me to submit to the operation; but upon the nature of the operation being explained to him, he declined the permission, because he feared the effect might be to turn the eye the other way.

I make this statement in justice to my friend and quondam master, and to show that we have surgeons in this country as learned in their profession as some in Europe. Respectfully, your obedient servant,

Samuel Y. Atwell.

To Henry W. Rivers, M. D., Providence, R. I.'

"Then follows a report of two cases successfully operated on by Dr. Rivers on Dec. 23, 1840, and Jan. 13, 1841, respectively, by dividing the rectus muscle (externus, first case, divergent; internus, second case, convergent). (*Philadelphia Medical Examiner*, IV, 119.)

"Soon after that William Gibson, who was then professor of surgery at the University of Maryland, actually operated for this condi-

tion. Dr. M. D. Reese, in 1842, in his supplement to the "*Surgical Dictionary*" of Samuel Cooper (p. 127), refers to the subject in these words:

"'It appears from the "*Institutes of Surgery*" that Professor Gibson attempted the cure of strabismus by dividing the recti muscles of the eye precisely as now practiced, some twenty years since in Baltimore. Soon after, he repeated it unsuccessfully, in Philadelphia, in several cases, and was induced to abandon it by the unfavorable opinions expressed on the operation by Dr. Physick. He, however, inculcated the propriety of the operation on his class many years since, and Dr. A. E. Hosack of New York, then one of his pupils, distinctly recollects Dr. Gibson's expressions of confidence that the operation would ultimately succeed.'

"Dr. Gibson himself in the sixth edition of his '*Institutes of Surgery*,' published in 1841, describes in detail the operations which he performed in 1818, and also adds that on the advice of Dr. Physick he was led to abandon these experiments."

Thus Dr. Hubbell. Here is the passage referred to in Gibson's work, the "*Institutes of Surgery*," 6th ed., p. 375: "The treatment of this disease will depend very much upon its cause. If it should arise from disease of the brain, from amaurosis, from morbid condition of the sixth or third pair of nerves, little benefit may be expected from general or local means. But if it proceed, as often happens, from teething, from worms, from violent passions of the mind, disorder of the digestive organs, irritation, temporary injuries, from partial exposure of one eye to the light, from want of power in one set of muscles or inordinate strength in the other, much may be done towards effecting a cure, partly by constitutional remedies, and partly by mechanical contrivances, or by an operation. Every effort should be made, then, to accomplish such a purpose, before resorting to the latter measure.

"In the year 1818, while practicing my profession extensively in Baltimore, the late Mr. B. J. consulted me about his daughter, a child of eleven or twelve years of age, both of whose eyes were directed very much inwards, and were thereby greatly deformed by a squint. I advised a pair of goggles, so contrived, by having a small opening in the center of each, as to oblige the child to direct the cornea to these openings,* and by perseverance for several weeks, succeeded in diminishing the deformity, but not in effecting a cure. In the course of my

* An invention of Ambroise Paré, and, long before him, of Paulus of Ægina. See, herein, the sketches of these two men, with (under **Paré**) a cut of the Paré strabismus mask.

visits the child remarked, at different times, that her eyes felt as if tied by a string. Struck with the observation, and conceiving the disease might depend upon shortening of the internal rectus muscle, I determined, the first opportunity, to try the result of division of that muscle; and as the friends of my young patient were unwilling the experiment should be first tried upon her, I selected a hospital patient, and after some difficulty in fixing the ball, and in cutting the muscle across, succeeded in restoring the eye partially to its natural situation. Upon two other patients I repeated the experiment, without much better success, but upon dividing the muscle in a fourth patient, after my removal to Philadelphia, the eye was so completely turned to the opposite direction as to bury the cornea beneath the lids, and create a much greater deformity than had previously existed. Upon showing the patient to Dr. Physick, he advised the experiments to be abandoned, as likely to be followed by very unfavorable results. I mention these circumstances, not from a desire to receive credit as an inventor, or to detract from the claims of the distinguished surgeon with whom the modern operation of strabismus originated, but merely as a curious fact, calculated to show the importance of not hastily laying aside processes apparently founded upon correct principles, simply because we are at first foiled in our attempts to execute them. How much benefit would have resulted to the community, if I had followed up my operations, until I ascertained the proper mode of conducting them, or how much injury I might have inflicted upon individuals by perseverance in the attempt, I shall not stop to inquire. It is sufficient for me to announce the fact,—which I have no doubt could be easily substantiated by many pupils who attended my early lectures, some of whom have indeed already proffered their testimony,—without being over solicitous, in setting up a claim as an inventor, of exposing my awkwardness and perhaps want of knowledge of the principles that should have guided me in following out the practice I had attempted to institute.''

Hirschberg, at page forty-two of his ''*Amerikas Augenärzte im 19. Jahrhundert*,'' comments: ''W. Gibson does not claim the priority. And it could not be presented to him.'' The fact that Gibson does not claim priority has little to do with the real question, which is, Was, or was not, Gibson the first to perform the strabismus operation? As a matter of fact, I believe that he was, but it would be to establish a vicious precedent to allow a claim of priority to be established by any one after very many years of silence on the procedure in question, and especially after the re-discovery of that procedure by another person who carried it on to a successful degree of development (which

had not been done before) and then had presented it to the world. (See, in this connection, **Dieffenbach** and **Stromeyer,** both in this *Encyclopedia.*)

Dr. Gibson invented a "scissors for operation of absorption of cataract," which is thus described: "So delicate as hardly to exceed, in size, the iris knife of Sir William Adams, and at the same time, so strong and sharp as to cut, with ease, the most solid and compact lens and capsule, without injuring, in the slightest degree, any part of the eye. These scissors are formed on the principle of Mr. Willaston's scissors, used for common purposes—with the edge so constructed as to operate like a knife. On this account, the instrument perforates the coats of the eye with the utmost facility, and when introduced, the blades can be opened to a certain extent so as to cut the lens to pieces without bruising it or any other part—the necessary effect of scissors, as they are usually made. This instrument possesses another advantage—the lens is supported in its natural situation during the operation, by having one blade behind, and the other before it, so that it may be cut to pieces, *in situ*, and its remains afterwards forced, by the shut blades, into the anterior chamber, for dissolution."

Dr. Gibson also invented the so-called "seton method" for producing the absorption of cataract, a procedure which he employed in three cases. He passed a common sewing needle through the sclera, two lines from the cornea, then through the opaque lens, and out through the sclera of the opposite side. "The silk being drawn through and the ends cut off, a single thread was thus left passing through the ball of the eye and acting on the diseased lens in the manner of a seton." In two of the cases "no reaction or accident intervened, and at the end of ten days, in both cases, the diseased lens had disappeared." In a third case, however, the operation "failed in consequence of the iris being wounded."

Gibson married, in early life, Sarah Charlotte Hollingsworth, by whom he had three sons and two daughters. Later, he married a second wife, by whom he had three children.

The doctor "was five feet seven inches tall, broad and round-shouldered." He had very bright eyes, and a genial and vivacious manner. His hobbies were to fight tobacco and to keep an exhaustive diary. According to James Gregory Mumford, he kept a diary for sixty years, which ran to 150 volumes. This, however, seems not to have kept afloat upon the stream of time. He was, for some years, vice-president of an anti-tobacco society.

Dr. Gibson, after his retirement from practice, became a great

traveler. But at length, bowed down by the weight of 80 years, he died at Savannah, Ga., in the winter of 1868.—(T. H. S.)

Gicht. (G.) Gout.

Giemsa's stain. See page 766, Vol. I of this *Encyclopedia.*

Gierl, Matthias. A well-known German surgeon and ophthalmologist, whose life-dates are unknown. He received, however, his medical degree at Landshut in 1817, and afterwards practised at Augsburg and Lindau. He wrote "Das Hypopion oder Eiterauge und Seine Behandlung" (Augsburg, 1825; Ital. Trans. by Schönberg at Naples, 1826) and "Ueber die Resorption der Cataractösen Linse in der Vorderan Augenkammer" (*Bayerische Annalen,* Bd. I).—(T. H. S.)

Gifford's reflex. Harold Gifford (*Klin. Monatsbl. f. Augenheilk.,* p. 201, 1906) observed an involuntary resistance to eversion of the upper lid as an early symptom of Graves' disease. It is probably due to irritability of Mueller's muscles. Dalrymple's (generally called Stellwag's) symptom, viz.: the exposure of the sclera above the cornea in ordinary horizontal fixation is possibly the static form of the symptom. See **Exophthalmic goitre.**

Gift. (G.) n. Poison.

Giftbohnen. (G.) Jequirity.

Giftkunde. (G.) Toxicology.

Gillet de Grandmont, Pierre Anatole. A celebrated Parisian ophthalmologist. Born at Paris, March 28, 1834, he received his professional degree at the university of that city in 1864. He was ophthalmologist to the Educational Institute of the Legion of Honor, and General Secretary of the Society of Practical Physicians. He died at Paris, in July, 1894.

His most important writings are as follows: 1. Cure Radical des Tumeurs et Fistules Lacrymales (Paris, 1860). 2. De l'Examen Ophthalmoscopique pour le Diagnostic des Tumeurs de l'Encéphale (Paris, 1861). 3. Pilocarpine dans les Affections Oculaires (Paris, 1878). 4. De Termination de la Sensibilité de la Rétine aux Impressions Laminenses Poloriées (Paris, 1881). 5. Des Courants Electriques Continus Appliqués au Voisinage de l'Oeil (Paris, 1883). 6. Deux Formes Nouvelles de Kératite (Paris, 1888). 7. Perioptométrie et Chromotopsie (Paris, 1888).—(T. H. S.)

Gillot, Joseph François de Paule. A well-known French military surgeon, of some slight ophthalmologic importance because of his "Sur les Aveugles et les Sourds-muets de la Ville de Metz." He was born at Robécourt, April 1, 1792, became a military surgeon in 1809, was engaged in military service for several years, received the medical

degree in 1817, and practised at Medonville, Neufchâteau and Metz successively. He died Aug. 18, 1868.—(T. H. S.)

Gilmore, Arnold Plummer. A prominent ophthalmologist of Chicago, Illinois, during the period 1880 to 1905. He was a native of Pennsylvania, born near Philadelphia, Jan. 27, 1851. He attended preparatory school at an institution near Pittsburgh and went thence to Trinity College, Hartford, Conn. While in his junior year, during a vacation, he was accidentally shot when hunting and lay for many months in slow recovery. During that trying period he decided to adopt the profession he later followed and honored. He matriculated

A. P. Gilmore.

at Jefferson Medical College, and after graduation there practised for a short time in Philadelphia, but feeling the need of a wider knowledge, went to Germany and studied for two years. He came to Chicago in the early eighties and soon took a prominent place in the professional and social life of that city. A democrat in politics, he became a factor in that party's municipal activities, and in 1889 was elected a member of the first Board of Trustees of the Sanitary District of Chicago. He rendered valuable services in his official capacity till his resignation (in December, 1895) from the Board, a step necessitated by his ever-increasing professional duties. He died Oct. 10, 1906.

Dr. Gilmore was of dignified and courtly presence; he had a host of admirers and always exhibited to those who came in contact with him a naturally kind disposition and friendly manner.—[Ed.]

Gimbernat's collyrium. See Vol. IV, p. 2341 of this *Encyclopedia*.

Gimbernat, Don Antonio. A celebrated Spanish surgeon, who discovered the so-called "Gimbernat's ligament" (which forms the inner boundary of the upper opening of the crural canal), who invented the treatment of aneurysm by graduated compression, and who possessed a little interest ophthalmologically. Born at Gambrils, Tarragona, Spain, in 1734, he studied at Cadiz, became professor of surgery at Barcelona, and finally removed to Madrid. Here he became body-surgeon to the King, Charles III. In 1787 he founded the College of Surgeons at San Carlos, and was for many years its director. His most important writing is "Neuvo Metodo de Operar en la Hernia Crural" (Madrid, 1793. In this work it was that he first described the ligament with which his name is still associated). According to Hirschberg, he read at Paris in 1800 a paper on corneal ulcers. These affections he divided into two kinds: A superficial, which is secretory, and a deep, which is foul. The former he treated chiefly with an alum wash; the latter, with a solution of potassium carbonate. According to the same authority, Gimbernat, when 78 years of age, was successfully operated on for double-sided cataract by Don José Rives, of the College of San Carlos; but, the very night that followed the operation, the impatient patient, removing his bandages, put his eyes to first one test and then another, with the result that one of the eyes was blinded completely and the other to a great extent.—(T. H. S.)

Gimelle, Pierre Louis. A celebrated French military surgeon, who devoted considerable attention to diseases of the eye. Born Nov. 6, 1790, at Saint Bonnet Alvert (Corrèze), he became a military surgeon in 1808, was engaged in military service for several years, was present at the battle of Waterloo, received the Doctor's degree at Paris in 1818, and died June 19, 1865. His only ophthalmologic writing was "Notice sur la Nature et la Traitement de l'Iritis."—(T. H. S.)

Ginger. *Zingiber officinale.* According to Dioscorides, ginger was used in his day as a local application for corneal cicatrices.—(T. H. S.)

It must be remembered that some of the first cases of methyl amaurosis in this country arose from drinking the domestic "extract" of (Jamaica) ginger, the usual grain alcohol menstruum of which had been adulterated with deodorized wood alcohol, the so-called Columbian spirits.

Gioppi, Giannantonio. A well-known Italian ophthalmologist, the date of whose birth is not known, but who practised at Padua and died in January, 1872. Gioppi's writings are: 1. Storia di un' Amaurosi (Padua, 1853). 2. Resoconto ed Osservazioni Pratiche Raccolte nella Clinica Oculistica dell' I. R. Università di Padova (Padua, 1858).

3. Cenni Nosologico-Terapeutici sulle Congiuntiviti Contagiose (Padua, 1856).—(T. H. S.)

Giorgi, Giuseppe de. A well-known Italian surgeon, who seems to have devoted considerable attention to ophthalmology. He was professor of surgery at Imola, and died in 1837.

His only ophthalmologic writing was entitled "Mem. sopra un Nuovo Istromento per Operare le Cattaratte e per Formare la Pupilla Artificiale" (Imola, 1822).—(T. H. S.)

Gipsy flower. See **Cynoglossum officinale.**

Giraldès, Joachim Albin Cardozo Cazado. A celebrated French anatomist and surgeon, of Portuguese descent and birth, who paid considerable attention to diseases of the eye. Born at Porto, Portugal, he received his early education in Madeira, his medical training, however, at Paris, where he graduated in 1836. He died at Paris, Nov. 27, 1875.

His ophthalmologic writings are as follows: 1. Etudes Anatomiques, ou Recherches sur l'Organisation de l'Oeil, Consideréé chez l'Homme et dans quelques Animaux (Graduation Thesis; 7 Plates). 2. Rech. sur la Disposition Croisée des Fibres de la Rétine chez les Cephalopodes (*Bull. de la Soc. Philos.*, 1845). 3. De la Fève de Calabar (Paris, 1863). 4. Sur un Cas de Cataracte Double chez une Jeune Fille de 15 Ans. (Paris, 1865).—(T. H. S.)

Giraud-Teulon, Marc Antoine Louis Felix. A Parisian ophthalmologist. Born at La Rochelle, May 30, 1816, he received his medical degree at Paris in 1848. He practised at Paris, and died at St. Germain-en-Laye, Aug. 19, 1887.—(T. H. S.)

Girault, Jean. A German dentist and ophthalmologist of the early 19th century. He invented an instrument for the introduction of a thread into the lachrymo-nasal canal in the course of the operation for lachrymal fistula.—(T. H. S.)

Girdle-shaped opacity. See **Band-shaped keratitis.**

Girdle, Visual. In some animals the visual purple forms a deeply tinted stripe running horizontally across the retina.

Girofle. (F.) Clove.

Gitter. (G.) Grating; trellis; lattice.

Gittrige keratitis. (G.) Lattice-like opacity of the cornea.

Glabella. (L.) The protuberant (but occasionally depressed) surface between the two superciliary ridges.

Glace. (F.) Ice.

Gland. A name given to numerous secretive and excretive organs of the body, whose chief function is withdrawing from the blood material for other purposes, or of excreting waste or injurious matter. A few of the glands of importance to ophthalmologists will

be mentioned under **Gland,** including **Glands** captions, but the majority of them are described in the sections devoted to the organs of which they form a part. In most instances a reference to the headings **Anatomy of the eye** and **Histology of the eye** will be profitable.

Glanders. Farcy. A disease of horses, communicable to man, and due to the *Bacillus mallei.* It is marked by acute febrile symptoms, inflammation of mucous membranes, especially of the nose, with a purulent discharge from the nose and an eruption of isolated nodules on the skin and mucous membranes. These nodules coalesce and break down, forming deep ulcers, which may end in necrosis of cartilages and bones. In man the disease usually runs an acute course, ending in the typhoid state and in death.—(Dorland.)

Rare cases of primary infection of the lids with the *Bacillus mallei* have been reported by Krajewsky, Scheby-Buch, and Neisser. Differential diagnosis from syphilis or tubercle may be impossible without bacteriological examination. Primary infection of the conjunctiva has been seen. Lachrymal fistula and abscesses in the orbit are reported. In animals ocular complications are, according to Dupuy, not uncommon (111 times in 167 horses).

Filatow (*Klin. Monatsbl. f. Augenh.*, p. 100, Jan., 1908) reports a case of human glanders affecting the eye in which the primary lesion was an ulcer of the upper lid, which perforated the lid and was followed by panophthalmitis. When evisceration was done, ulceration of the lower lid was noticed. The patient died of the general infection.

Glandilemma. The capsular covering of a gland.

Gland, Interocular. In comparative anatomy, the ectocranial portion of the epiphysis cerebri. It is regarded as the rudiment of the third eye.

Gland of Bruch. Clusters of Bruch. A number of follicles in the conjunctiva, mostly congregated within the folds of transmission. See **Histology of the eye**; also, **Anatomy of the eye**.

Gland of Kölliker. One of the tubular glands of the olfactory region.

Gland, Pineal. A small, reddish-gray, vascular body situated behind the third ventricle, which is embraced by its two peduncles; it is also called the *conarium,* from its conic shape. It rests upon the pregeminum and is connected with the thalami by two peduncles. Its function is unknown. It is considered to be the remains of the pineal eye of lower vertebrates.

Glands, Baumgarten's. These are tubular glands of the conjunctiva, occurring in the nasal side of the lids.

Glands, Ciaccio's. A name for Waldeyer's or Krause's conjunctival glands. See a footnote in Parson's *Pathology,* Vol. I, p. 3.

Glands, Ciliary. See **Ciliary glands**; as well as **Histology of the eye.**

Gland, Harder's. See p. 2689, Vol. IV, of this *Encyclopedia.*

Glands, Henle's. Conjunctival depressions between the papillæ described by Henle in 1866.

Glands, Krause's. These are conjunctival, true, large acino-tubular glands found below the surface between the margin of the tarsus and the fornix, particularly on the nasal side. There are from six to eight in the lower cul-de-sac and about forty-two in the upper.

Glands, Lachrymal. LACHRYMAL GLAND. See page 350, Vol. I, of this *Encyclopedia.*

Glands, Meibomian. See p. 348, Vol. I, of this *Encyclopedia.*

Glands of Moll. Modified sweat glands of the lid margin. See **Anatomy of the eye**; also, **Histology of the eye.**

Glands of Zeiss. Small sebaceous glands emptying into the follicles of the cilia. See **Histology of the eye.**

Glands, Pre-auricular. ANTERIOR AURICULAR GLANDS. Three or four small lymphatic glands situated in front of the external ear. These receive the lymph and excreted material from the external ear. In many infections of the eye—chancre, chancroid, vaccinia, gonorrheal ophthalmia, Parinaud's conjunctivitis, tuberculosis of the conjunctiva, etc.—these glands may become tender and swollen, but rarely, if ever, suppurate, although the induration may remain.

Glands, Submaxillary. These are spheroidal salivary glands of about half the size of the parotid, situated one in each submaxillary triangle, covered by the skin, fascia and platysma myoides, and resting on the hyoglossus, mylohyoid, and styloglossus muscles. Each gland is separated from the parotid gland by the stylo-maxillary ligament, and is grooved in its posterior and upper portion by the facial artery. It discharges into the mouth through Wharton's duct.

In various disorders, Mikulicz's disease, epithelioma of the lids, vaccinia of the eyelids, conjunctival lymphoma, purulent conjunctivitis, for example, these structures may become infected and inflamed.

Glands, Waldeyer's. These acino-tubular glands are found in the conjunctiva near the upper border of the tarsus. See **Histology of the eye.**

Glandulæ thyroideæ siccæ. Thyroid extract.

Glandular conjunctivitis. ADENOLOGADITIS. (Obs.) Terms originally employed to designate inflammation of the lining membrane of the Meibomian ducts in the eyelids; and since erroneously applied to any glandular inflammation of the lids.

Glandulöse Augenentzündung. (G.) Chalazion.

Gland, Uveal. A name given by Nicati to the secreting portions of the ciliary body, and especially to that portion excreting the aqueous humor.

Glan's prism. A particular form of polarising prism.

Glanz. (G.) Luster; shine.

Glänzend. (G.) Shining, lustrous.

Glare. A dazzling, or blinding light; a disagreeably intense brightness; as, the sun's glare on water. See **Dazzling.**

Glaring. Dazzling. The intense light, as well as its effects upon the eye, of the sun, electric furnaces, electric arc lights and other powerful artificial illuminants. The ocular relations of these sources of light are discussed under such captions as **Eclipse amblyopia; Arc lights; Blindness, Snow;** and particularly under **Dazzling,** page 3778, Vol. V, of this *Encyclopedia.* See **Eyes of soldiers, sailors, etc.**

Vogt (*Arch. f. Aug.*, 74, p. 41), observed with others, that if he fixed a bright surface, e. g., the sky, white clouds, snow, white paper or linen, illuminated by the sun, with one eye, while the other was closed, the white surface after a few seconds changed its hue. Especially in the central portion of the visual field pale pink alternated with greenish to yellowish tints. If now the accommodation is relaxed and the eye stares at the bright surface, a from relative to absolute, scotoma commences at the center and expands towards the periphery. The obscured round area of from 30° to 40° is black-green, shading into yellow or violet after longer fixation. At the moment at which the bright surface is again fixed the scotoma disappears. Hence Vogt formulates the following: We are able to voluntarily arouse in our visual apparatus, exposed to a bright surface of constant objective luminosity, an alternation, which consists in the voluntary generation and suppression of colored images of glaring (relative scotomas), and especially in complete obscurations of the central visual field (absolute scotomas). It is independent upon convergence, accommodation, width of pupil, and is most likely located in the region of cones. He explains it by a variability of the subjective luminosity dependent upon our will. It is assumed that these changes are transmitted by the centrifugal fibers of the visual path and are located in the retina.

Schanz, of Dresden (*Deut. Med. Woch.*, February 20, 1913, No. 8, p. 365), gives a very good synopsis of the action of the different kinds of rays of light, which excite the sensitive elements of the retina directly, indirectly, or not at all. All three reach the anterior segment

of the eye and act on the parts which are not permeable by light, the more intense, the more short-waved they are. The transparent parts of the eye are influenced only by the rays which are absorbed by these parts. These are chiefly the short-waved rays, which by being absorbed by the cornea irritate the sensitive nerves and in the conjunctiva cause the distressing symptoms of pressure, burning, lachrymation and, by longer action, catarrh of the conjunctiva, electric ophthalmia, etc.

A large portion of the short-waved rays after passing through the cornea into the lens are partly absorbed by this, partly converted into rays of greater wave length, causing the fluorescence of the lens. Their augmentation does not seem irrelevant for the lens. The cataract of glass blowers and the occurrence of senile cataract in tropical India at a much earlier age may be attributed to these rays.

The fluorescent light irritates the retina by glaring. A part of it, the lavender gray, is the fluorescent light of the retina. Another part is not transformed and, on more intense action, produces microscopic changes of the retina. Functionally they seem to diminish the dark adaptation of the eye. By continued action they may produce chronic electric ophthalmia and disturbances of the color-sense.

For protecting the eye euphos glass seems best adapted, as it absorbs very well the indirectly-acting rays and very little the visible rays. By absorbing the rays which produce fluorescence in the eye vision is increased by this glass, as found empirically by hunters. Gray euphos glass and Fieuzal glass absorb the indirect rays and weaken the visible rays like the smoked spectacles. In the United States various shades of amber, as well as Noviol and the Crookes tints, are commonly prescribed for the same purpose.

R. Cords (*Arch. f. Augenheilk.*, Vol. 75, p. 224, 1914), after considerable experimentation, gives the following results: If one eye, instead of being covered, is darkened by a deeply-tinted glass, and a bright surface is fixed, a central zone of obscuration is evoked, but always in the color corresponding to the glass.

If in bright sunlight one eye is closed, instead of being covered, so that the yellowish-red of the blood, circulating in the lids, is seen, the zone of obscuration has a yellowish-red hue. This becomes grayish-black if a screen which excludes all light is placed before the closed eye.

If the light proper of the retina of the covered eye has from previous illumination a certain color, this appears in the zone of obscuration. If, e. g., the retina by wearing of a yellowish-red glass is exhausted for this color, the zone of obscuration in the visual field of the other eye appears bluish-green.

If previously to the experiment a negative after-image is aroused

in the covered eye, it appears simultaneously with the zone of obscuration in this.

Zeozon is a monoxid-derivative of the glycosid esculin, which is found in the bark of the horse-chestnut, and has been introduced by Unna in the form of a paste for the protection of the skin against the undesirable effects of sunlight. Ruhemann used zeozon-water (a from 0.3 to 0.5 per cent. solution of the ortho-oxid derivative of Unna's preparation in boric acid solution), as an eye wash in 40 cases of glaring, and reports, that all distressing symptoms disappeared after four instillations per day.

At the instance of von Hess, Pincus (*Archiv. f. Augenheilk.*, lxxiii, p. 291) investigated the properties of zeozon experimentally. He found by spectrographic-photographic methods that a thick layer of zeozon-water absorbs the ultra-violet rays, but not in thin layers. His experiments on rabbits proved without exception that instillations of zeozon-water into the eye are not capable of protecting it in any way against the action of ultra-violet rays, a result which, in view of the physical conditions regulating the absorption of rays of light by fluids and the physiologic processes following introduction of fluids into the conjunctival sac, was to be expected from the start. He therefore urgently warns against relying on zeozon-water for protection against glaring.

Glasäugig. (G.) Wall-eyed; glassy appearance of the eye.

Glasbläserstar. (G.) Glass-blower's cataract.

Glasdose. (G.) Eye cup.

Glaserne Feuchtigkeit (or Augenfeuchtigkeit). (G.) Vitreous humor.

Glashaut. (G.) Cornea.

Glaskassette. (G.) Glass container for cotton wool, gauze, etc.

Glaskörper. (G.) Vitreous body.

Glaskörperstaar. (G.) (Obs.) Hyaloid cataract.

Glaskörperstaub. (G.) Dust-like opacities in the vitreous.

Glaskörperstränge. (G.) Vitreous filaments.

Glaslamelle. (G.) Vitreous or glass-like layer (of the choroid).

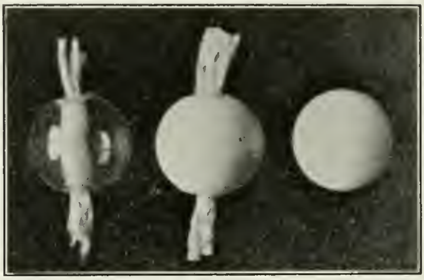
Glass. A substance resulting from the fusion of a combination of silica (rarely boric acid) with various bases. It is usually hard, brittle, has a conchoidal fracture, and is more or less transparent, some kinds being entirely so, while other substances to which the name of glass is commonly given are, in consequence of the impurity of the material or imperfection in the manufacture, only slightly translucent. Glass is an inorganic substance, as would naturally be inferred from its being the result of fusion, but some organic substances are called vitreous. Some rocks have a vitreous structure, like that of artificial

glass, as, for instance, obsidian, which is often called *volcanic glass.* The slags produced in furnace operations are vitreous substances, but usually only translucent, and not transparent, because the vitrification is incomplete, and also because they are too deeply colored by metallic oxids. Glass, as the word is generally understood, is an artificial product, and one of the most important of manufactured articles. Its valuable qualities are: the ease with which it can be made to take any desired shape; cheapness, the result of the small cost of the materials of which it is made; durability, and especially resistance to decomposition by acids and corrosive substances generally; transparency, a quality of the utmost importance, as evidenced by its use for windows and in optical and chemical instruments; and the beautiful luster of those kinds which are used for ornamental purposes. Almost the only drawback to these good qualities of glass is its brittleness. The bases used in glass-manufacture are chiefly soda, potash, lime, alumina, and oxide of lead, and the quality of the article produced depends on the nature and amount of the basic material united with the silica. The combinations of silica with a simple alkaline base, either potash or soda, are soluble in water, and are known as *water-glass.* They are useful substances, but very different in their properties from what is ordinarily known as glass.

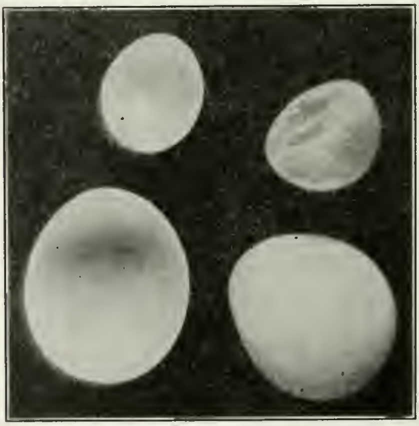
In addition to the alkaline base there must be an alkaline earth or a metallic oxid. The cheapest glass is that used for bottles; in this the basic material is chiefly lime, with some potash or soda, and alumina. Glass for medicine-bottles differs from ordinary bottle-glass in containing more potash than the latter, and also in the greater purity of the material used. Window-glass usually contains both soda and lime; here absence of any tinge of color is important, except in the most inferior qualities. Potash and soda render the glass more fusible; alumina diminishes its fusibility; lime makes it harder; lead gives luster, fusibility and high refractive power. Hence, in glass which is to be cut and polished, where beauty is of prime importance, the base is chiefly oxid of lead, which amounts in some cases to half the weight of the material used. Glass in which lead is the essential base is called *crystal or flint-glass.* The finer kinds of glass without lead are called *crown-glass.*

The tools employed by the glass-blower are simple, but require dexterity for their use. The process of manufacture depends on the fact that, at a very high temperature, glass is a liquid which can be readily cast; at a full red heat it is soft, ductile, and easily welded; when cold, it is hard and brittle. Glass to be serviceable must be annealed after the desired form has been given to it. This is done

by heating it nearly to the melting-point, and then allowing it to cool very slowly in an annealing-chamber. By the action of hydrofluoric acid, which combines readily with the silica in glass, etching can be done on a glass surface. When cold, glass can be ground or cut upon a wheel, scratched by a diamond-point (by which means sheets of glass are readily divided or shaped, as they will break easily along the lines of such scratches), cut and depolished, or "ground" by a sand-blast, and brought to an exceedingly high polish.—(Abridged from the *Century Dictionary.*) See, also, **Glass, Optical.**



Glass Balls with and without Openings for the Passage of Sutures.



Glass Bodies of Acid-Proof Glass.
To be used as casts for enlarging the orbital cavity.

Glass balls. Apart from their use in Mules' and similar operations—all of which are described and depicted under **Enucleation**—acid-proof glass balls are occasionally used as pressure-bodies for enlarging a cicatricial orbit. See figures.

They are occasionally provided with openings through which sutures may be passed and the balls sewn into the cavity of the orbit or even of the denuded eyeball.

Glass-blower's cataract. About the verity of this form of traumatic (glare) cataract there seems little or no doubt, although it is probably rare. L. Stein (*Archiv. für Augenheilk.*, Vol. 84, p. 53, 1913) had an excellent chance, during seven years, to examine the large body of workmen at the Kreuznach glass-works. He reports that the majority were of rather poor physique and frequently, as they got older, suffered from asthma and lung tuberculosis. They nearly all had emphysema of the parotid. To make up for the great loss of fluid by perspiration most of them drank enormous quantities of fluid, chiefly beer and coffee, up to ten litres a day.

Stein made a point of examining with the aid of homatropine every case that came before him. In this way the majority of his cataract cases were discovered accidentally. He gives a table of 55 persons examined, in 28 of whom cataract was present, in some stage or other. He comes to the conclusion that the cataract usually begins at the posterior pole in the left eye, the right eye being affected later. The posterior polar opacity is either rosette-shaped, in which case the rest of the lens may remain clear for a long period, or it is in the shape of a round opacity, in the middle of which a more dense point appears; in this form it is usual to find an anterior polar opacity developing later together with cortical opacities. In one case in which the right eye was first affected, the workman, contrary to the usual practice, had held the right side of his face next the oven. Although posterior polar cataract is to be regarded as the type characteristic of the disease, there were several patients in whom the seat of the opacity was in the nucleus or cortex.

Stein had operated on six; the first by discission with subsequent evacuation of the swollen lens, and the remainder by extraction six weeks after a preliminary iridectomy with massage. There were no complications, but he found the nucleus much larger than was to be expected from the age of the patients, and advises a large section. The extracted lenses were examined by Hess, who failed to find any peculiarities.

In the works at Kreuznach an effort is made to protect the eyes of the workmen from the ultra-violet rays, by means of sheets of colorless glass which are fixed about half a metre from the ovens, and so arranged that the workmen look through them while carrying on the necessary manipulations with the hands beneath. These have been in use for some considerable time. The wearing of any form of pro-

tective glass by the workmen is rendered impossible by the profuse sweating. See, also, **Cataract** headings.

Glasses, Colored. See page 2388, Vol. IV, of this *Encyclopedia;* also **Dazzling.**

Glasses, Convex and concave. See **Lenses, Ophthalmic**; as well as **Eyeglasses and spectacles, History of,** and other **Eyeglasses** captions.

Glasses, Franklin. Bifocal glasses. See **Franklin glasses**; as well as **Eyeglasses and spectacles, History of.**

Glasses, Hyperbolic. Those ground in the form of an hyperbola.

Glasses, Periscopic. The best example of an eye glass or spectacle lens whose refracting surfaces conform to the surface of the globe (and is consequently *periscopic*) is the toric lens. According to W. S. Dennett, a solid developed by the revolution of a circle about any axis other than its diameter is known as a *torus.* A toric lens may be described as one which is cut from a toric surface by a plane parallel to its axis of development. The optical centering of such a lens requires that both its centers, the center of its circle and the center about which in its development the circle revolves, shall be on the axis of the system.

Glasses, Prismatic. See **Prisms**; **Glasses, Reading**; also **Hand-glass.**

Glasses, Stenopaic. Those consisting of a blackened disc of metal in which is placed a small, round hole or a narrow slit; they are used for examining and correcting errors in astigmatic eyes.

Glass eyes. PROTHESES. See **Artificial eye.**

Glass, Optical. By optical glass is meant a quality of glass suited for the production of high grade prisms, lenses, etc. It must be produced in great variety so that the designer of optics may have as wide a choice as possible of glass differing in dispersion and refractive index. It must have in a great degree such characteristics as freedom from color, striæ, and large bubbles, and it must be without internal stresses.

Glass-making is largely dependent upon chemistry, and peculiar kinds of glass are required if we are to obtain the best results in spectroscopes, polariscopes, microscopes, and refractometers, as well as in other instruments so useful and necessary to the optician, the oculist, the chemist, and to members of other professions.

Progress in glass-making and in optics has been almost simultaneous. Prior to 1886 glass-makers were offering a very limited variety of optical glass to the makers of refracting instruments, and the perfection of such instruments was necessarily limited to the possibilities presented by a few crown and flint glasses. Two lenses had been combined into a doublet so as to bring pairs of colors to a common focus on the optical axis of the lens, thereby diminishing chromatic aberration. Means to render the image almost entirely free from spherical

aberration had also been devised, but no attempts had been made to introduce new glasses, effort being expended only in perfecting technical manipulation and in adding to the list of dense flints.

There were a few exceptions to this general condition. Frauenhofer, a German optician, succeeded in finding glasses which showed a diminution of the secondary spectrum, but the new glass was not produced on a commercial basis and the formula was lost. In 1825 Faraday was appointed by the Royal Society, together with Sir John Herschel and Mr. Dolland, on a committee to examine and to improve the manufacture of optical glass. A complete report was made in 1829, and, although the glass resulting from a very exhaustive and systematic series of experiments did not prove of much practical use, yet the work had much directive influence on subsequent researches. Harcourt, an English clergyman, carried on a number of experiments and established certain facts relating to the effect of certain chemical elements upon the refraction of light; but his meltings were so small that pieces large enough and sufficiently perfect to permit complete spectrum analysis could not be obtained, and, lacking information which can be gained only with the spectrometer, his subsequent work suffered for want of guiding experience.

Up to this time silicon, sodium, potassium, calcium, lead, and oxygen had been the only elements used in glass-making, except, perhaps, aluminum and thallium in an experimental way. Crown and flint glasses were, however, being produced of a far better quality as regards clearness, homogeneity and freedom from color; moreover, flint of far greater refractive power and dispersion appeared than had been offered up to this time. But there were only two glass works filling the popular demand, and the difficulties connected with taking up work in this field, the great expense of the experimental work, and the uncertainty of even limited success in the near future discouraged everyone from taking up the manufacture of new glass in competition with the existing makers. Even if successful the proportion of optical glass to the total amount of glass consumed was so small that no great financial returns could be expected.

In the late seventies Professor Ernest Abbe, of the University of Jena, published a paper on the microscope in which he made an appeal to scientists to take up the improvement of optical glass, pointing out that the microscope, as well as all other optical instruments, was in a state of arrested development awaiting such perfection in glasses as would offer a great diversity in mean index and mean dispersion, and render possible a higher degree of achromatism, thus diminishing the secondary spectrum. He also pointed out that the optical glass supply

might be seriously affected or permanently discontinued by a single accident owing to production being in the hands of so few, and he urged someone to undertake the manufacture of optical glass.

His plea attracted Otto Schott, and after communicating with Abbe the two began an investigation of the problem, seeking first of all to determine the chemical-physical principles underlying the making of optical glass. Schott carried out the experimental work, while Abbe and Riedel made the spectrometric measurements and conducted other tests. The experimental meltings did not exceed 60 grams, and were intended to determine just what elements would enter into the composition of glass and influence refractive power and dispersion. With the knowledge thus gained the scope of the work was enlarged and combinations of ingredients were systematically made on a larger scale, the meltings weighing up to 10 kilos. It was not until 1886 that some results were published, and it was then determined to undertake the commercial production of optical glass as well as to continue the research work.

In experimenting with various combinations of chemical elements the following limitations must be borne in mind: The flux must not act upon the crucible and so absorb impurities from that material; elements which evaporate during the process tend to produce veins in the glass and therefore must not be used; cloudiness, crystallization and bubbles must be avoided in the processes of melting, cooling, and subsequent reheating; it must be possible to bring the glass from the plastic to the solid state without producing stress; glass must not be tarnishable nor hygroscopic—that is, it must not be attacked by the moisture of the air; it must be colorless and strong enough to bear manipulation in grinding and polishing.

These various limitations cannot be made less severe, and when considered together present an array of difficulties hard to overcome.

Besides silicic acid or sand, the only glass-making oxides are boric acid, phosphoric acid, and perhaps arsenic acid. There was a theory that these three oxides give tarnishable glasses, but this was investigated by combining phosphoric and boric oxides with as many metallic oxides as possible, the first meltings being made in small crucibles and later in larger quantities up to 25 kilos in melting pots of porcelain or fire-clay. In addition to the six elements so long used in glass-making 28 new ones were introduced by degrees in quantities of at least 10 per cent. These were boron, phosphorus, lithium, magnesium, zinc, cadmium, barium, strontium, aluminum, beryllium, iron, manganese, cerium, didymium, erbium, silver, mercury, thallium, bismuth,

antimony, arsenic, molybdium, niobium, tungsten, tin, titanium, uranium, and fluorine.

For thoroughly mixing the contents of the crucible a porcelain agitator was revolved rapidly and automatically raised and lowered 5 cm. or 10 cm. Porcelain crucibles were used, but in spite of active stirring it was impossible to obtain large pieces free from veins. Hoping for better results, a platinum crucible holding 3 litres was used with a platinum stirrer weighing 1½ kilos, but numerous bubbles appeared at the contact of the glass and platinum, and the crucible disintegrated so rapidly that it was good for but four meltings. Other attempts were made with a very thick crucible, and the fact established that while platinum could be used for melting boric glass, phosphates dissolved the metal and exuded it again in gray masses during cooling. Special sorts of fire-clay pots were finally found to be most satisfactory.

Optical glass must be free from the stress acquired in solidifying, and this fact adds another problem to glass manufacture. After many trials and subsequent testings with polarized light, a process called fine annealing was perfected. Ovens with thermo-regulators whereby the temperature may be kept at any point between 350° and 470° C., and allowed to fall with any desired slowness, were used. It was determined that the temperature of solidification is between 370° and 465° C., and by spreading this fall of 95° over an interval of four weeks or more perfect results were obtained.

It was soon seen that with the introduction of new elements a variation of the hitherto fixed relations between refraction and dispersion could be attained, but on the other hand very few of the new elements render the dispersion of crown and flint more similar, whereby a shortening of the secondary spectrum could be effected. Boric acid is peculiar in lengthening the red end of the spectrum relatively to the blue, while fluorine, potassium, and sodium have the opposite effect. It is characteristic of the old glasses that flint has a higher index and greater dispersion than crown, and lengthens the blue more than the red, hence it was desirable to introduce into flint glass as high a percentage as possible of boric acid. The problem of lengthening the blue relative to the red in crown glasses is not an easy one. Sodium has only a slight influence, and when the mixture contains of it more than 30 per cent. the glass is tarnishable. Fluorine would be very advantageous in combination with lithium, barium, aluminium, phosphoric acid and calcium, but as decomposition of the fluorite takes place during the manufacture and the silicic-fluoride gas given off attacks the crucible it cannot be used. In phosphate and borate

glasses alkalies must be used very sparingly or tarnishing is inevitable. By adding alumina, zinc oxide and barium oxide the sensitiveness could be sufficiently overcome. A number of elements had to be excluded on account of their coloring influence or rarity.

All this work, being merely empirical, was very tedious, but at last notable results were achieved. A series of flint glasses containing boric acid was established, by the aid of which it was possible to make three-lens systems free from secondary spectra, but these glasses were not so permanent as the older ones. A valuable series of boro-silicate crown glasses with a lower refractive index and dispersion than the ordinary crown was obtained, and these are now extensively used for prisms and small objectives. The dense barium crown glasses, using barium and boric acid, were perfected, and these glasses are used in nearly all "anastigmat" photographic lenses.

Up to 1886 the net result of all these epoch-making discoveries was nineteen glasses of essentially new optical characteristics, and to these more than twenty have since been added. The most important result, however, was the established possibility of offering a wide range of refractive index and dispersion to the mathematical optician, who is now able to regard these two properties as more or less independent of each other.

The introduction of these new glasses caused a revolution in the scope and manufacture of optical instruments. One can well imagine the expectancy of Abbe, who now for the first time saw the cherished hopes of years approaching fulfilment. First of all, he applied these new glasses to the objectives of the microscope, and with their aid and in connection with other discoveries of a physical nature which he had made, he was soon able to construct microscopes which resolved structures with an exactitude and certainty hitherto unapproached. The stimulus given to microscopic research was immediate. New telescope constructions have been found using these glasses, and in the field of photography the application of new optical glass has been of great significance. Anomalous pairs of glasses needed for flattening the field were available, and achromats could be made in which the positive lens has a higher refractive index and less dispersion than the negative lens. The now well-known type of anastigmat was discovered with the aid of the new glass.

More recently, investigations have been carried on in an effort to produce glass for spectacles and goggles to prevent cataract and other diseases of the eye which affect glass-makers. The ideal glass for this and similar purposes should first of all cut off the heat rays, then the ultra-violet rays, and, finally, transmit the highest possible

percentage of the harmless luminous rays. The heat rays are from the infra-red end of the spectrum, and the ultra-violet has a bad influence, as shown by the intense fluorescence of the crystalline lens when ultra-violet light is thrown upon it. Luminous rays in excess are harmful. The experiments consisted in adding elements to a soda-lime glass flux and testing the resulting glass for heat rays by a special apparatus in which black mica was used to cut off light but which allowed heat to pass through. Absorption of ultra-violet light was measured by a quartz spectrograph, luminous rays by Chapman-Jones opacity balance and color by the Lovibond tintometer (q. v.). While some very excellent results have been obtained and valuable information tabulated, not only as regards the original problem but regarding the reduction of glare from snow or sea, yet the ideal result has not yet been reached. Glasses that accomplish one (in some cases two) of the desired ends have been obtained, but one which passes what is considered a proper percentage of luminous rays and yet cuts off a large percentage of infra-red and ultra-violet rays is yet to be produced. See **Eyeglasses and spectacles, History of**; also **Glaring**; and **Colored glasses.**

Glass is undoubtedly a solid solution in which silicic acid or other acid-forming oxide is the solvent, and the other components the solutes. This accounts for much of the behavior of glass, as, for example, the after-working observed in thermometers and the lack of homogeneity in optical glass which, however, becomes less as the glass ages. Parts of a solution adjust themselves so that the solution becomes uniform because the different molecules find no obstacle to their free movement. In glass this readjustment is rendered much more difficult, hence the comparatively long time required for the proper aging of optical glass. Where aging does not accomplish perfect homogeneity we must resort to hand correction to produce a surface as perfectly plane as possible.

Several characteristics of glass have received careful consideration. These are density, tenacity or tensile strength, resistance to crushing, elasticity, hardness, specific heat, conductivity of heat, cubical expansion, thermo-endurance, and the chemical behavior of glass surfaces, as well as physical properties, such as refraction and dispersion. In considering these characteristics the question naturally arises whether the characteristics of the glass can be foretold from the nature of the oxides used in making it. If this could be done then the properties of the oxides in glass could be determined from observations of properly-selected glasses, and when values had been assigned to the oxides the approximate character of any glass containing them could be

determined in advance. In compounding a special glass to meet a given requirement this would be of great help, but in practice it does not work out very well, although computed results differ from those observed by only 1½ per cent., with a maximum difference of 4 per cent., where density is under consideration; yet with other characteristics the differences are great enough to defeat the plan. Information has been tabulated regarding the influence of the various elements upon these different characteristics.

It is interesting to note that the demand for purely optical glass is not sufficient to make its manufacture a profitable industry apart from other types of glass. This is due to the high cost of the experimental work and to the fact that, as a rule, not more than 20 per cent. of a large melting comes from the annealers suitable for optical use.

In glass-making every step in the process and each raw material are controlled with the utmost care. The raw materials must be analyzed and kept free from contamination, there must be the most rigid control of temperatures, the proper regulation of combustion, etc. One of the difficulties is the production of suitable pots—a science in itself. The aging of the clay is a step carefully watched, and bacterial action plays an important rôle in its ripening. Various types of pots, both open and closed, are employed, and frequently a period of ten months passes from the time the pot is started until it is ready for use. It is then gradually warmed until red hot, when it is transferred to the melting furnace and sealed in. When the temperature reaches the melting point of the glass to be made the pot is glazed inside with pieces of glass from a previous melting, the glazing being accomplished with an iron ladle. The mixture is then shoveled in in layers until the pot is full of molten material, after which it is kept at a high temperature for a considerable time. Great care is required to maintain the proper temperature during this refining process; and the arrangements, together with the skill of the operatives, makes it possible to maintain a given temperature from 10° up to 1500° C.

If the temperature is too low bubbles are not removed, and if too high the crucible itself is attacked. At the conclusion of this operation the temperature is allowed to fall slightly and the scum is taken off the pot. A red-hot stirrer of fire-clay, shaped like a hollow cylinder, is next introduced and allowed to remain for an hour or more, to allow air bubbles to rise to the surface. The handle of the stirrer is an iron tube cooled by circulating water.

The glass is tested from time to time by blowing small flasks, to determine its clearness. When sufficiently clear the stirring is continued for three or four hours, the mass gradually cooling meanwhile.

and when the stirrer can be removed only with great difficulty it is taken out. The oven is next unsealed and the pot, which with the glass may weigh from 1500 to 2000 pounds, is removed on a truck to an annealing oven, or allowed to remain in the yard to cool, as the case requires. The process of shifting the pot is important and must be effected rapidly to prevent too sudden cooling. Pots on iron carts are surrounded with inflammable material and the transfer is made by rail.

In the annealing oven the temperature is controlled to within 5° C., and the mass cooling down generally flies into pieces during the four or more days it is kept there. The pieces are carefully examined, faulty portions hammered off and rejected. Every piece from a given melting is marked with the same number, which is the number under which the glass is sold. The good glass is moulded into plates in fire-brick moulds, and in some instances the fine annealing is done simultaneously.

When the plates have been formed, annealed and cooled they are polished on two opposite sides or edges and carefully examined with a spectrometer and with a polariscope to determine any remaining defects. In this shape it is received by the manufacturing optician, who must saw from the plates suitable pieces for grinding and polishing to produce the lenses his formulæ require.—(H. E. Howe.)

Glass, Soluble. Potassium or sodium silicate.

Glassy. Having the appearance of glass. Fixed and expressionless (said of the eyes of the dead).

Glassy membrane. Bruch's membrane. Lamina vitrea. The homogeneous membrane that lines the choroid. See page 1317, Vol. II of this *Encyclopedia.*

Glastine. Of a bluish color.

Glatt. (G.) Smooth.

Glauber's salt. See **Sodium sulphate.**

Glaucoma. Gouty eye. Glaucosis. In the discussion of this large and important subject, it was considered wise to divide the labor among several collaborators. The Editor feels that he has been fortunate in having secured the services of Drs. Wm. Campbell Posey and Burton Chance, of Philadelphia, to write this *major heading*, the former taking up the *operative treatment*, the latter writing the *introductory portion, including the symptomatology, pathology and prognosis of the disease.* For the minor portion—*non-operative treatment*—the Editor is responsible, as well as for bracketed sections.

Also, this section should be read in connection with **Tonometry;**

Circulation of intraocular fluids; Filtration, Ocular; Blood pressure; Buphthalmus; and other related sections.

Definition. Glaucoma is a disease characterized by increased tension of the globe and gradual or sudden impairment or loss of vision. It formerly indicated, according to Von Graefe, "a vague expressionless symptom, a sea-green, a bottle-green, or dirty-green background of the eye, seen through a fixed, dilated pupil." Broadly speaking, the term glaucoma is applied to all those conditions in which the intraocular pressure is abnormally increased. Priestley Smith has defined it tersely as "an excess of pressure within the eye, plus the causes and consequences of that excess."

History. The term glaucoma is of great antiquity. To the ancient writers such a disease as glaucoma could not have been known in its early stages, neither do they appear to have recognized it as associated with any distinct form of disease, and, from the time of Hippocrates to the early part of the XVIII century, the term was applied to cataract as well as to other states.

As Thos. H. Shastid points out regarding the origin of this term, Hippocrates employed not "glaucoma," but "glaucosis," and that but a single time. The sense in which he used the term has never been exactly made out, but he probably meant to cover the condition which, today, we know as "cataract." By the Greco-Roman writers, "glaucoma" would seem to have meant "light blue." In a pseudo-Galenic manuscript occurs this definition: "Glaucoma is an alteration of the natural fluids (humors) into a clear blue with complete blindness." Still later, it appears that in amaurosis there is no perception of light and the pupil is altogether clear; but, if the pupil is bluish, the condition is termed "glaucoma." Neither condition is curable. If, however, the pupil that has suffered a change of color, still retains some light perception, then the condition is known as hypochyma (Lat. *suffusio;* since Constantinus Africanus, "cataract"). The next important clarification of ideas occurred when Rolfinck (in 1656), and, later, Brisseau and Maître Jan (*q. v.*) pointed out and demonstrated the true location and nature of cataract—i. e., that a cataract is essentially a clouding of the crystalline lens, and not, as had been formerly supposed, the flowing down of an inspissated humor into a (purely imaginary) cataract space between the pupil and the lens. All this time, however, the idea of hypertonia had never been entertained. With Müller and von Graefe entered that conception, which, thenceforward, has been the essential idea of glaucoma.

Brisseau demonstrated by his post-mortem examinations that glaucoma is not due to an affection of the lens; he ascribed it to disease or

turbidity of the vitreous humor. Terson, in an account of his researches concerning the earliest mention of the hardness of the eyeball in glaucoma, states that J. Platner, in a work published in 1745 in which he ascribed certain cases of glaucoma to an affection of the crystalline lens, gave evidence of his knowledge of the hardness of the globe to finger pressure. More careful discrimination was shown throughout the succeeding years of that century, so that by 1821, Demours, in an extended description, referred to the increase of tension, and associated glaucoma with over-sensitiveness of the nervous system, but ascribed the disease to gout and rheumatism. Yet it was not until 1830 that Mackenzie observed that hardness of the globe and an increase in the contents of the eye were accompaniments of the condition of what was by that time denominated glaucoma.

In the succeeding twenty years many hypotheses were advanced as to the cause; certain observers attributed it to disease of the retina or of the optic nerve, while others, among whom was Mackenzie, ascribed it to an affection of the choroid. Nothing yet had been devised to relieve the symptoms, and the prognosis remained unfavorable; moreover, as it was not until the invention of the ophthalmoscope that it became possible to diagnose the non-inflammatory types and to study the morbid changes which preceded the final stages, only the inflammatory types were known and studied prior to 1850.

In 1854, Mackenzie advised that "paracentesis of the cornea, or of the sclerotic, affords great relief of pain." Albrecht von Graefe's observations on animals, and his study of cases of iris-adhesion after corneal ulceration and of staphylomata, in which, after iridectomy had been performed, he noticed that the tension was permanently lowered, led him to propose iridectomy as an effectual means for mitigating the tension of the globe and relieving the glaucomatous condition (yet for several years Desmarres, in Paris, had practised paracentesis in the manner advised and emplyed by Mackenzie, although in his hands it had afforded only temporary relief). In 1855, Donders observed the significance of the adhesion of the iris to the posterior surface of the cornea.

In 1856, Heinrich Müller demonstrated anatomically the pressure-excavation of the optic nerve, and, a year or so later, Weber and Förster accurately diagnosed it with the aid of the ophthalmoscope.

So late as the middle of the nineteenth century the morbid process was so completely mysterious that no chapter in ophthalmology has been so prolific of hypotheses, nor so productive of such serious and laborious investigation, as that on glaucoma, and all notwithstanding von Graefe's beneficent and epoch-making discovery. Indeed, for

fifteen years, his very success in the relief of thousands of glaucoma patients, led him and the foremost observers to search for the cause of the production of glaucoma and the mystery of its cure; and we are still trying to improve our methods of treatment.

Donders, noting that simple glaucoma was unaccompanied by inflammatory symptoms, believed the increase of tension arose through irritation of the secretory nerves in the eye; others associated the activity of the secretory nerves with trigeminal neuralgia; others still regarded it as the effect of angioneurosis, which led on to congestion of the globe.

In the last quarter of the nineteenth century certain of the hypotheses of all time were pursued with infinite pains and the atmosphere became clearer by reason of more exact methods in histologic study, especially the study of eyes removed because of secondary glaucoma. Leber advocated that the cause lay in the obstruction of the angle of the anterior chamber; his researches were amply corroborated by Knies and Weber, and their conclusions are universally accepted. Priestley Smith, confining his studies to the changes observed in the crystalline lens throughout life, in 1879 advanced the idea that primary glaucoma depended upon the increase in the growth of the lens, or rather in a disproportion between the size of the lens and the size of the eye.

In more recent years the thesis of Thomson Henderson has greatly stirred the ophthalmic world. He claims that sclerosis of the pectinate or cribriform ligament is the cause of the obstruction in the filtration area. Nevertheless, the differences of opinion which the investigations have evoked are a measure of the intrinsic difficulty connected with the subject; and the end is not yet seen.

Varieties. Glaucoma is spoken of as "primary," or "idiopathic," when it does not appear to have been caused by any previous fundamental disease of the eye, and "secondary," when it occurs as the sequel of preëxisting diseases, especially inflammation of the uveal tract, in which the increase of tension is only a consequence of other pathological conditions.

The *primary variety*, to which the term glaucoma ought to be restricted, is a common disease, constituting about 1 per cent. of all cases of eye disease. It is manifested either as an acute congestive ("inflammatory") glaucoma, or as the subacute, or chronic, congestive glaucoma; and as the chronic non-congestive ("non-inflammatory") glaucoma, which is spoken of clinically as the "simple glaucoma."

While it is convenient to adopt these classifications and terms, they are purely artificial, because any stage may be but the modification

of one and the same morbid process; indeed, acute glaucoma may lose its congestive symptoms so that the condition passes over into the chronic variety; while simple glaucoma may at any stage develop congestive symptoms and terminate in the manner of the acute form. Hirschberg has reported a case that remained quiet under his observation for twenty years only to have an outburst of congestion demanding enucleation.

Priestley Smith, whose labors entitle him to preëminence among the English-speaking investigators, would have us bear in mind how closely the two forms are related, and also to observe that the term "primary" really means "without antecedents," and that pathological and clinical evidence seem to show that acute and chronic glaucoma are essentially of a like nature, each depending proximately on the obstruction of the filtration angle, though the closure occurs quickly in the one case and slowly in the other.

Clinical history. It is common for both eyes to be subject to attacks of glaucoma, which connection depends not in the way of sympathy, but upon the fact that the conditions which are likely to lead to the disease usually exist in both eyes. And it is not common for the two eyes to be affected equally and simultaneously; it is usual for the symptoms, especially in the non-congestive types, to be manifested in the fellow eye months or years after the first became affected. It may be stated generally that the more acute the disease in the one first involved, the shorter will be the interval before the other suffers.

Increased hardness of eyeball. There are certain well-defined symptoms common to all forms of primary glaucoma, all of which, however, may not be present in a given case. The first, and most important symptom is a rise in the intraocular tension, or an increased hardness of the eyeball, from which all the other phenomena arise. The inevitable consequences of a continued increase of tension are excavation of the optic nerve and the reduction, with the ultimate annihilation, of the sight of the affected eye.

A rise in the intraocular tension may be manifested in an increased hardness of the eyeball, varying from a degree of "doubtfully increased tension" (T plus ?), in which the sclera presents more than the usual resistance to the palpating finger, to one of "extreme tension," or "stony hardness," in which the finger cannot indent the sclera by firm pressure. There may be intermediate degrees, from but slight, though positive, increase ("T plus 1?"), to that of considerable tension ("T plus 2"), in which the finger can but slightly impress the coats. While it is always convenient to estimate the degree of intraocular tension by means of the finger, the method is

nevertheless inexact, for since the introduction of the use of tonometers, the only accurate way to express the tension is in terms of pressure-weight or of pressure-degrees. (See **Tonometer,** and **Tonometry.**) With the Schiötz tonometer the normal tension varies between 12mm. to 27mm. of mercury; a tension of more than 27mm. is certainly pathologic.

Cloudiness of the cornea. When the intraocular pressure is increased and the tension of the tunics suddenly raised, a condition of edema or cloudiness of the cornea is set up from the interference with the flow of the corneal lymph. The corneal surface then resembles a sheet of glass which has been dulled by being breathed upon. (A similar appearance, however, may be noted sometimes in iritis and irido-choroiditis.) Minute drops of fluid collect beneath the epithelium and between the fibres immediately under Bowman's membrane, in closely aggregated points, which gives the cornea the well-known appearance of being "needle-stuck." The cloudiness of the cornea, being more pronounced in the centre than at the periphery, is quite visible and is that which gives rise to the peculiar obscuration of vision so distinct in this form of glaucoma. This haziness is commonly marked in the congestive types, being usually absent, or is present in only a slight degree, in the simple glaucoma.

Ciliary injection. A sudden access of pressure from an embarrassment of the flow through the choroidal veins invariably causes the engorgement of all the external vessels, with more or less edema of the conjunctiva and swelling of the lids; while sometimes, when the engorgement is intense, there may be proptosis. In acute glaucoma there is usually a general hyperemia of the conjunctiva and often chemosis. The arteries becoming hypertrophied, in consequence of the increased resistance to the entrance of blood into the eye, the flow through the anterior ciliary veins is augmented, so that tortuosity of the fine scleral branches may be present. The arteries are to be distinguished from the veins by their greater tortuosity, by their very abrupt disappearance at the points where they perforate the sclera, and, when pressed upon by the finger, by the greater pressure required to empty them, and, when the finger is removed, by the reëstablishment of the current in a direction from the equator towards the cornea.

The edema of the anterior segment of the globe may obscure the characteristic markings and otherwise efface the distinct patterns of the iris; and at the same time the veins of the iris may become so greatly dilated, distended and tortuous as to burst, so that the surface of the membrane becomes dull from the presence of minute hemor-

rhagic effusions. The vitreous may become clouded and the lens cataractous, and through the pupillary space there may be transmitted the greenish reflex from the surface of the lens—a reflex so characteristic of glaucoma from the earliest times that it was from this symptom that the ancients named the disease—*glaukos,* sea-green.

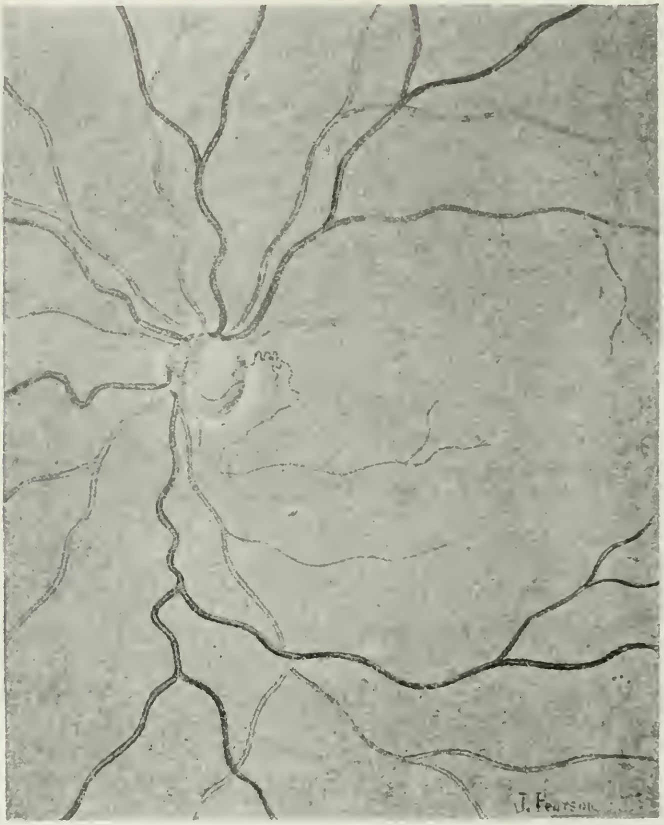
Change in depth of the anterior chamber. A common symptom in primary glaucoma is the diminution in the depth of the anterior chamber brought about by the pushing forward of the lens and the per-

Normal Optic Nerve Entrance. (Maitland Ramsay.)

ipheral portion of the iris. The depth varies in different cases from an almost imperceptible degree to the complete obliteration of the chamber; yet entirely healthy eyes may have quite shallow chambers. It is difficult therefore to decide just how much the shallowness of the chamber has been caused by the glaucomatous process and just how much the shallowness is the cause of the glaucoma.

Dilatation of the pupil. Ordinarily in glaucoma the size of the pupil is increased and its shape so altered that it is no longer round but oval or egg-shaped. The mobility, too, of the iris becomes sluggish if not totally inactive; yet, in some instances, abnormal pupillary symptoms may be entirely absent.

The dilatation of the pupil depends upon paresis of the ciliary nerves, together with the lowering of the blood supply to the iris through the constriction of the vessels. This constriction arises from the compression of the iris base with its accompanying paralysis of the iris muscle. The irregularity in the shape of the pupil may



Ophthalmoscopic Appearance of Cupping of the Optic Disc. (Maitland Ramsay.)

depend upon inequalities in the pressure on the nerves and vessels. The sphincter pupillæ may remain amenable to miotics for several days.

Excavation of the optic disk. When the excess of pressure has continued for some time the optic disk becomes transformed into a cup—the so-called glaucomatous cup—owing to the recession of the lamina cribrosa, or that part of the sclera which lies at the point of entrance of the optic nerve into the eye. This lamina is perforated

by numerous foramina designed for the passage of the bundles of the nerve. It is, therefore, the weakest spot in the wall of the eye as well as the most impressionable, so that by the force of glaucomatous pressure it gives way, and the intraocular surface recedes.

The cup may vary in extent from one displaying only a slight concavity of a portion of the disk's surface, to one presenting the most complete excavation of the nerve head, the excavation extending from scleral border to scleral border. Over the abrupt edge of such a cup the vessels are seen to bend sharply and then disappear under the overhanging scleral margin, and to reappear deeper but fainter at the bottom of the cup, where the dark spots of the cribriform layer shine distinctly. With the ophthalmoscope the depth of the cup may be shown by the parallactic movement of the floor of the cup when the mirror is moved in the vertical plane, and by the fact that a concave lens is required to focus the floor. The strength of the lens required also gives the depth of the cup—each diopter of refraction corresponding to 0.30 mm. of depth.

With the invention of the ophthalmoscope much was expected regarding this disease, but the expectations were not realized for several years after. Julius Jacobson was the first to use it in the investigation of glaucoma, but his dissertation, published in 1853, arrived at purely negative results. The appearance of the nerve-head, too, was not easily understood, for Jaeger, in describing the glaucoma cup mistook it for a globular swelling of the disk.

Encircling the pallid and often greenish discolored papilla is a yellowish ring, the so-called "halo"—which has been produced through atrophy of the choroid from the effects of the increased pressure within the globe.

The mechanism of the production of the cup is uncertain and is still a matter of dispute. It is likely that in the early stages of the disease congestion and edema of the optic nerve occur, if not actual inflammation. The cupping therefore does not take place immediately, neither during, nor even after a first attack of acute glaucoma, because the process requires time for its completion, and is a consequence of atrophy of the nerve head; for, without doubt, the excavation is dependent upon the recession of the lamina cribrosa, and, if the changes of the optic nerve arise from the excess of pressure, it is by the loss of balance between the intraocular pressure and the nutritive resistance of the nerve.

The glaucomatous cup is to be distinguished from a large physiologic cup, and from the excavation observed as a sequel to atrophy of the optic nerve. A physiologic cup or excavation occupies but a portion

of the surface of the disk and is of the normal tint, while an atrophic excavation, though it may be complete, is usually shallow and is found in an avascular, pearly-white nerve head. A glaucomatous excavation is, on the contrary, complete, deep and often of a greenish hue. The glaucomatous cup is to be distinguished from that of simple atrophy by the depth of the excavation and the interruption of the vessels at the margin of the disk. While these descriptions apply at the same time to marked or typical forms, it is most difficult some-

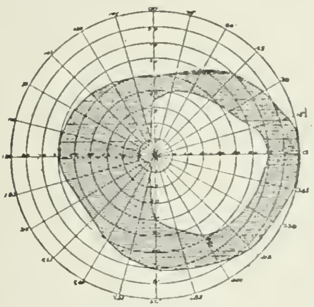
Glaucomatous Cupping of the Optic Disc. (Maitland Ramsay.)

times to decide in other less well-defined cases, for, when simple atrophy occurs in a disk in which there is already a large physiologic cup the resulting condition may closely resemble a typical glaucomatous cup. In simple atrophy of the disk, there has been a loss of nerve-substance and consequent retraction of the surface quite up to the margin of the papilla, just as in glaucoma, yet the excavation remains shallow and is never undermined as in glaucoma, because the lamina cribrosa itself has not been displaced.

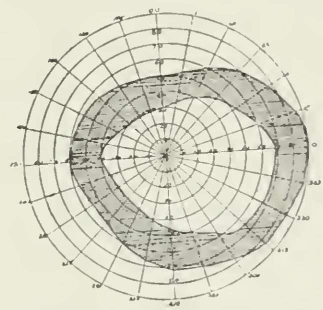
Changes in the intraocular vessels. The central portion of the vessels, in the earlier stages of the disease present, according to the graphic description by Stellwag v. Carion, quite clear and well-defined borders.

The arteries are of normal calibre, or somewhat narrow; the veins are broader in consequence of their being flattened by the intraocular pressure, and frequently surrounded by a net-work of small, anastomosing branches. At a subsequent period of the disease all the vessels occupying the region of the papilla become paler and indistinct as though veiled by a thin, grayish haze, and ultimately almost wholly disappear. The retinal veins and arteries then appear to spring directly from the margin of the disk. The larger veins seem to end in a roundish point, of a much darker tint than the rest of the vessels.

Pulsation of the vessels. A striking characteristic rarely seen on the disk in the healthy eye, but often in glaucoma, is an arterial pulsation. Another result of the increased pressure on the retina is the obstruction to the entrance of the arterial and the exit of the venous



Field of Vision of Right Eye. In a case of subacute glaucoma. Loss of the nasal half and concentric restriction of the preserved field. (From de Schweinitz, *Diseases of the Eye.*)

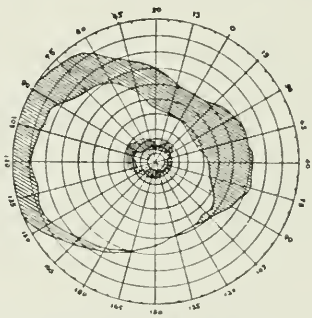


Field of Vision in Right Eye. In a case of chronic glaucoma, showing concentric restriction of the field. (From de Schweinitz, *Diseases of the Eye.*)

streams; the arteries consequently are but incompletely filled while the veins become congested. The veins, too, are rhythmically compressed at each incoming wave, so that a venous pulsation also is common, often most marked in the dark knuckles as they bend over the margin of the excavation. These phenomena were discovered by von Graefe, who noticed the arterial pulsation on the papilla when the eyeball was very hard; yet venous pulsation is frequently seen in eyes of normal tension, although not so often as in glaucoma. Donders demonstrated that the arterial pulse can be induced in healthy eyes by a gradual increasing pressure on the globe, and he noticed also that at the moment when the pulse appears, vision is temporarily abolished. As a consequence of the obstruction in the retinal circulation, retinal ecchymoses may be seen scattered over the fundus, and occasionally aneurysmal dilatation of the arteries and bead-like varicosities of the veins are seen.

Anesthesia of the cornea. The sensitiveness of the cornea is commonly affected and anesthesia may be observed during an attack of glaucoma, and again in the later degenerative stages, varying from a slight depreciation only to an entire loss of sensation. Sometimes the anesthesia is not uniform but may exist in spots or segments of the surface of the cornea. The anesthesia is caused by a maceration and compression of the nerve filaments by the fluid which has become collected in the canals of Bowman's membrane.

Pain. The sensitive ciliary processes becoming swollen and squeezed by the sudden congestion, the tunics too are stretched by the increasing pressure. Mackenzie and other early classical writers observed that the subjects of glaucoma often labored under symptoms which they ascribed to forms of irregular gout, and it was noted further that they not infrequently suffered from such pains in the teeth and



Annular Scotoma in Chronic Glaucoma. Moderate contraction of the peripheral field. (From de Schweinitz, *Diseases of the Eye.*)

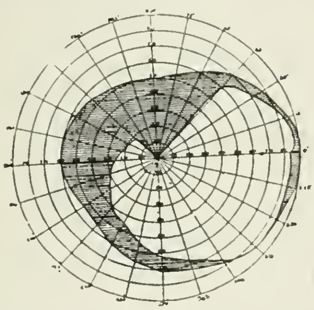
head as were generally counted rheumatic. And, in these later times, although in some cases it may be entirely absent, pain is a usual accompaniment of increased intraocular pressure. In the violent congestive cases the agony is intense, with great physical depression and weakness. The countenance is pallid and frequently there are seizures of nausea and vomiting. It is in the experience of all clinicians to observe how profound a depression glaucoma-pain can produce, and to note the equal rapidity with which the health rebounds after operation or the excision of the globe.

In chronic cases the rise of pressure is so gradual that the vessels and nerves have time to adapt themselves to the altering conditions, and accordingly there may be only a general feeling of discomfort, with occasional darting neuralgia; or the patient may complain of a hemicrania or perhaps only a sense of fulness.

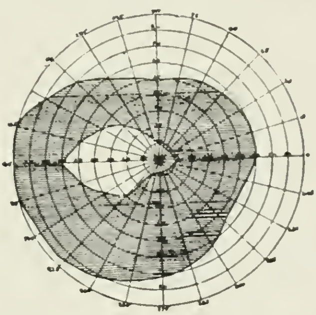
Alteration in visual acuteness. A characteristic symptom in acute glaucoma is the sudden loss of vision which in a few hours may be

reduced to the mere perception of light, while in malignant cases it may be rapidly annihilated. Generally, in each succeeding attack of the subacute variety the vision fails, but is gradually recovered as the attack passes off. At each recurrence of the attacks, however, a deeper and more permanent impression is left. In the chronic cases, sometimes, even when the disk is deeply cupped, excellent sharpness of sight may be preserved for a long time. It is not safe, however, as will be pointed out later, to depend upon the degree of the visual acuity as a guide to the rate of progress of chronic glaucoma.

Affection of the accommodation. One of the earliest symptoms of the ordinary type of glaucoma is the diminished power of the accommodation, as evidenced by the desire to change the reading-glasses for such as are stronger than the degree of refraction-error or the age of



Field of Vision in Right Eye in Case of Chronic Glaucoma. Showing sectional defect (superonasal quadrant). (From de Schweinitz, *Diseases of the Eye.*)



Field of Vision in Left Eye in Chronic Glaucoma. Trowel-shaped patch preserved chiefly on the temporal side. (From de Schweinitz, *Diseases of the Eye.*)

the patient would warrant. So, too, as an increase in tension tends to render the globe more spherical, there is manifested an alteration in the refractive power of the eye, depending upon a change in the shape of the cornea. During an attack of glaucoma, the general refraction is often higher by one or two diopters than it was before, or than it may be found to be after, the attack. The astigmatism is commonly "against the rule." The displacement of the lens tends to produce myopia, while the increased tension on the zonula tends to hypermetropia.

Alterations in the peripheral vision. More important than the depreciation of the central visual acuity are the alterations in the peripheral vision which are so characteristic of glaucoma. The center of the field retains for a time normal or nearly normal vision, while the periphery progressively contracts. The contraction of the field of vision is therefore an important index of the rate of progress in glau-

coma, and a careful map of the field is always necessary for a proper understanding of the effects of the increase of pressure on the retina. The contraction of the color-fields is usually proportionate to that of the form-field. Under the influence of operative measures or miotics very decided improvement in the extent of the visual field may take place.

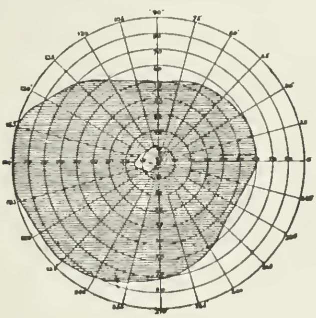
The tendency of the visual field is to contract progressively as the disease advances, until finally all portions except a small part upon the temporal side are obliterated, yet this portion also disappears in the ultimate blindness.

The contractions present certain typical forms, the most usual variety being the partial or complete loss of the nasal field, or the upper or lower quadrant of the nasal side. The next common is the concentric restriction of the entire field. In the next, the restriction is so constituted that the remaining field assumes an oval or triangular shape. Then follow those presenting sectional defects, often in the upper nasal area; the loss of the entire field except a patch on the temporal side; the formation of scotoma, which may be central, paracentral, annular or peripheral. These isolated scotomata may be the precursors of more extensive defects in the peripheral field.

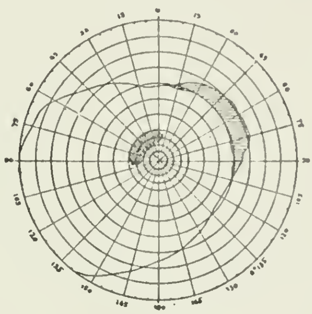
A search for scotomata is imperative; these may be found by either the ordinary perimetry methods, during which care must be taken to investigate each meridian with suitable test-objects, and under varying degrees of illumination, or, by the methods of Bjerrum. This investigator used small test-objects, and placed the patient at a greater distance from the point of fixation than is ordinarily employed. By his methods defects were found which would otherwise escape detection. According to Bjerrum, the earliest changes in the field of vision are not in the periphery but in the region of the blind spot; a normal blind spot therefore excludes glaucoma. He regards scotomata to be the result of the destruction of the fibres of the papilla at the margin or sides of the excavation. They are peculiar in that while they may spread towards the periphery in all directions, sometimes more in one direction than in another, except outwardly, yet they never pass beyond the blind spot. The defective area wherever situated, is in direct continuity, therefore, with the blind spot. This phenomenon is known as "Bjerrum's symptom." Topographically, such scotomata are different from those obtained in simple optic atrophy. The line of demarcation is well defined, and color-vision is usually retained in the sentient area—a point to be remembered in the study of the contracted fields of chronic glaucoma and those of optic atrophy due to other causes. Bjerrum found these defects in the region of the blind

spot sometimes before he could detect anything with the ophthalmoscope, and he believes that every case of glaucoma, if carefully examined with small test-objects, will show such a paracentral scotoma at some stage of the disease.

Rönne found in a number of cases an alteration in the nasal field consisting of a sharp, horizontal limitation to the defect in the nasal field, which he discovered by moving a small test-object radially 5 degrees above and 5 degrees below the horizontal line, giving the test-object a circular movement. This defect, he believes, is caused by the involvement of bundles of fibers which curve upwards and downwards from the papilla ending in a "raphé" on the horizontal meridian of the retina. Sattler, of Königsberg, is of the opinion that scotoma



Field of Vision of Left Eye in Chronic Glaucoma. Same case as previous illustration six months later; only a small patch of the preserved field on the temporal side. (From de Schweinitz, *Diseases of the Eye*.)



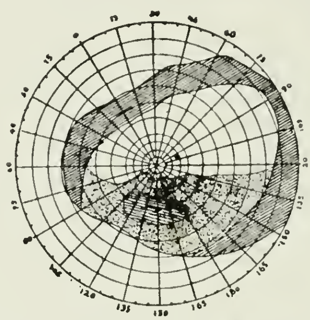
Chronic Glaucoma. Just beginning contraction of nasal field; scotoma extending from blind spot in a semicircular manner upward and inward. (From de Schweinitz, *Diseases of the Eye*.)

continuous with the blind spot (Bjerrum), and the peculiarity in the nasal field described by Rönne, are very important and characteristic evidences of glaucoma. Cases may arise in which the peripheral field is not contracted, yet paracentral scotomata can be found.

Seidel has used Bjerrum's method in the diagnosis of doubtful cases; he believes the test to be more delicate than Bjerrum thought, especially in such cases as those in which the eyeball and fundus are apparently normal, the intraocular pressure, as indicated by the tonometer, normal, and where the symptoms complained of are deemed to be only those of asthenopia. In such cases, he found paracentral scotomata, and, he believes, these paracentral are developed from lesser scotomata, which at first are scattered above and below but which later coalesce and unite to form crescentic or sickle-shaped scotomata. He advises that in all early cases search should be made for these scotomata as well as to map out the area of the blind spot.

and to note how they later become included with that area assuming the forms so well known.

Changes occur in the central light and color senses. According to Beauvieux and Delorme, the differential light sense is the first to be attacked, and is diminished even before ophthalmoscopic signs have become marked. This alteration is independent of the state of the central visual acuity and of the retraction of the visual field, but is due to the condition of the intraocular pressure. The absolute light sense is diminished, on the contrary, only when the glaucoma has advanced sufficiently to produce changes in the disk, and is therefore related to the accompanying optic atrophy. It, too, is likewise independent of the central visual acuity as well as of the state of the visual field. The color-sense is usually normal so long as the light-sense is



Visual Field of Right Eye in Chronic Glaucoma. Showing the mechanism of the loss of the lower and inner portion of the field, preceded by a scotoma which gradually extends. Scotoma represented by parallel lines; area of dull vision which subsequently is completely lost, by dots. (From de Schweinitz, *Diseases of the Eye.*)

unchanged, but when atrophy sets in it is not rare to find the color-sense affected.

Cloudiness of the cornea. ''Halo vision'' may be complained of during the early, transient edema of the cornea. There is dimness of sight in the day time and the appearance of a ring or rainbow-colors around luminous flames at night. The flame itself may be seen distinctly but around it is a dark zone beyond which is a rainbow of colors. This phenomenon depends on the alteration in the epithelium of the cornea, without doubt caused by the increased pressure from the congestion of the uveal tract. The same effect can be obtained experimentally; and it is well to remember that the same sensation has been noticed during the presence of thick mucous over the corneal surface in conjunctivitis.

Subjective light sensations. At times subjective sensations of light are experienced by the totally blind glaucomatous patients. Such sensations depend probably upon the pulling or mechanical drawing

of the optic nerve upon the retina. And, occasionally, even after blindness has set in, patients may be subject to attacks of vertigo, which Dor, of Lyons, believes to be dependent upon the effects of pressure in a sense organ, much as in the manner of Ménière's disease. In the cases he reports, relief followed on excision of the globe.

CLINICAL TYPES OF GLAUCOMA.

That important form, *acute congestive, or inflammatory glaucoma,* may be divided for convenience into two stages, the premonitory and the stage of glaucomatous attack. The premonitory symptoms are characterized by a sudden diminution in the range of accommodation with the desire for stronger and stronger reading glasses; one or more transient attacks of dim and rainbow-vision, arising without warning in one who has believed himself to be entirely free from all disorder. These early symptoms may follow an exhausting illness, a period of emotional excitement and restlessness, or depression or other anxiety, and sometimes after a too hearty meal. The eye may be attacked more or less suddenly and with vague pains in the forehead and temples, which the patient ascribes to neuralgia. The cornea and the aqueous humor may be more or less turbid and the pupil slightly dilated. During the premonitory attack the tension of the eye is increased. The symptoms may subside and the eye return to its natural state and remain quiet for a week or two, but similar periods of discomfort may recur and recur during a twelvemonth, if not over a period of years, when after a sleepless night, or during temporary excitement or undue muscular strain, as after excessive straining during constipation, or a hard fit of coughing in chronic bronchitis, or during the menstrual molimen—any intercurrent happening or condition that influences the raising of the arterial tension—another but more violent seizure occurs, ushering in a true glaucomatous-attack.

The pain in the side of the face and head increases hour by hour so severely as to excite nausea and vomiting. There may be flushing and fever, or the patient may be pallid and cold and profoundly depressed and prostrate. The vision is greatly impaired. The eyelids are swollen, the conjunctivas reddened and edematous, the cornea steamy and anesthetic, the eye watery and light intolerable. The pupil is more or less dilated and immobile, the aqueous turbid and the iris discolored. The anterior chamber is abnormally shallow. The tension mounts higher and higher by the finger test, or it may register from 70 to 80 mm. of mercury. Vision is rapidly lost, often only light-perception remaining, but this, too, may be abolished. Some-

times the attack is bilateral, the second eye becoming affected within a few hours. More commonly it is not attacked for weeks or months, or even years.

In the absence of treatment these acute symptoms last for several weeks and then subside, except for a slight impairment in the mobility of the iris, together with a little rise in the tension: and there may be a partial return of vision, but with a limitation of the peripheral field.

Physiognomy in Simple Chronic Glaucoma. (Maitland Ramsay.)

The ophthalmoscopic picture may be but little changed from the normal, although during the attack it is difficult if not impossible to examine the fundus. The arteries will be seen to be only slightly reduced in size and probably pulsating, the veins engorged and their main trunks near the disk collapsing at each arterial pulse. Extravasations of blood are occasionally discernible in the retina or the choroid.

After some weeks or months the symptoms reappear, and, after a number of attacks, if the eye-ground is examined during a remission,

the characteristic cupping, the halo and the steady arterial pulse may be revealed.

If the disease is not checked the eye passes into a glaucomatous state wherein the pupil is dilated and fixed, the iris discolored and from the lens the greenish reflex shines. The cornea is hazy, the anterior chamber shallow and opacities are seen in the vitreous. Gradually the vision is destroyed and the eye reaches the state of absolute glaucoma, in which the ball is stony hard, the iris degenerated, the anterior chamber obliterated by the cataractous lens which has been pushed forward by the excessive tension. The sclera is discolored, the pericorneal vessels coarsely dilated; the cornea is opaque and may become ulcerated even to perforation. Finally from changes in the vitreous, choroid and retina, the whole eyeball may become disorganized and shrunken. Occasionally the globe ruptures spontaneously while in others excessive choroidal hemorrhage occurs.

It is not easy to conceive how the globe can rupture without there having been some previous disturbance of the integrity of the coats. In most cases there has been ulceration of the cornea, and in some of these the ulcerated cornea has later on undergone necrosis and rupture has followed, the sudden lowering of the intraocular tension being succeeded by profuse hemorrhage. In a case of my own the cornea had become firmly healed, it was believed, but a sudden congestion of the eye led to the rupture of the choroidal vessels which was followed by elevation of the intraocular tension and rupture.

Coppez concluded, from a series of histological studies, that such ruptures are dependent upon a weakened corneal membrane augmented by hemorrhagic extravasation behind the choroid. Ruptures have occurred at the site of the wound long after the operation of iridectomy. The rupture may be followed by hemorrhage only, or by the extrusion of the lens and clots, as in my own case, or, as noted by Villard, by the complete extrusion of the contents of the globe.

Rarely, the onset of the symptoms may be so sudden and their course so acute that within a few hours their evolution may be so complete that eyesight is immediately destroyed. This process is spoken of as glaucoma fulminans, in which there is no remission.

Subacute or chronic congestive glaucoma. The subacute form may arise with scarcely any premonitory symptoms, or it may be the sequel of repeated more or less mild, acute attacks. It is characterized by its intermittency. The first few attacks may amount to nothing more than obscured and rainbow vision, but, later on, the attacks recur more frequently, the symptoms increasing in severity and the remissions less complete. The eye assumes a persistently congested condi-

tion, the cornea loses its transparency or it may be positively steamy; the sclera becomes discolored and the episcleral vessels tortuous. The aqueous appears turbid, the iris more or less atrophic, the pupil partially dilated, the deeper media increasingly opaque, and, when the fundus can be seen, the disk is found to be cupped with pulsating vessels. The tension is invariably elevated. Attacks of pain recur and recur, with an increase of all the other symptoms until ultimately after several months or a year, total blindness supervenes.

Chronic glaucoma (simple glaucoma). Chronic glaucoma, the "amaurosis with excavation of the optic nerve" of von Graefe, begins almost imperceptibly in persons at about fifty years of age. The history is usually obscure; perhaps the first symptoms, of mere haziness of the sight with "rainbows" or "showers," may be dated back to a time of worry or grief, business anxiety or other period of nervous exhaustion and depression. The progress is slow, with scarcely any exacerbation or remission. And as one eye is more commonly affected before the other, the patient may not complain at all until the sight of one eye is found to be practically destroyed.

Externally, little or nothing may be noticed; perhaps the anterior ciliary vessels are slightly enlarged, and the cornea steamy, or there is turbidity of the aqueous humor so that it lacks transparency. One, or both, pupils may be partially dilated, and, if both eyes are affected, one pupil is usually more affected than the other, in which case the pupil of that one is generally larger than its fellow. The depth of the anterior chamber may not be materially altered.

The tension of the eyeball is found to be distinctly increased. At first the excess may not be discovered until after repeated examinations at different times of the day. With the tonometer variations may be obtained, though the range may be but slight. Such variations are doubtless dependent upon the extent of the contact of the iris with the cribriform ligament. But when seen in the later stages the tension may have progressed to such a degree that the eye is stony hard, when by this time the disk has become deeply-cupped, and the vessels displaced.

In spite of these extensive changes there may have been entire freedom from pain and other subjective symptoms.

The lens may take on a grayish or greenish sheen, and in cases where the ophthalmoscope has not been used, a diagnosis of "cataract" has frequently been made, from which the patient has been advised to wait for "ripening," with disastrous results. In the earlier stages the central vision may be good, although the eye is usually hypermetropic, yet any errors of refraction may be easily corrected and

the vision brought to the normal standard. The maps of the fields of vision, however, are of importance in showing marked contraction, perhaps to such a degree as to show only a small area in connection with the blind spot.

The central color perception does not show any special loss, but there is contraction of the peripheral color-fields corresponding to that of the form-field.

Causes of glaucoma. Few subjects in ophthalmology are more important and none more obscure than that connected with the causes of primary glaucoma.

Predisposing causes. The objective symptoms already described as pertaining to glaucoma are not, of themselves alone, sufficient to give rise to glaucoma; indeed the same symptoms may be present in other inflammatory states. There seems to be a necessary predisposition required for its occurrence. Persons of the "spare habit," and the "dyspeptic," seem to be attacked more frequently than the fat, robust and lymphatic. Maitland Ramsay reminds us that "the disease is not to be looked upon as a morbid entity, but as a symptom-complex; and its true nature will be all the better understood if one thinks of its acute manifestations as analogous to an attack of angina pectoris. Its occurrences depend not only upon the size and immediate structure of the eyeball, but also upon the age, race and general health of the patient." We therefore find it associated with nervous affections, cardiac disease and circulatory disturbances or chronic intoxications.

Glaucoma sometimes occurs in several members of a family, appearing in two or more succeeding generations—even as many as five generations, as reported by Harlan, and in two or more members of one generation. It has been observed that when it has occurred in several generations the incidence in each succeeding generation is at an earlier age than the preceding. It occurs hereditarily in both the acute and chronic forms, and it may be transmitted by either sex or inherited by either sex. Unless the disease attacks the young members in its descent through several generations, it is not easy strictly to account for the hereditary transmission of glaucoma. It may be that some inherent disproportion in size between the corneal ciliary region and lens exists, or other anatomic feature, as of weak laminæ cribrosæ with steep physiological cups.

Age. It rarely attacks anyone before the age of forty; the liability is extremely slight in childhood and youth, although unilateral cases have occurred in children; less than one per cent. occur earlier than twenty.

It continuously increases up to and during the seventh decade so

that between 60 and 70 it is more than twice as common as from 40 to 50. Priestley Smith would have us remember that this is the period of enlargement of the lens.

Race. Whilst many cases occur in Jewish persons, it is uncertain that glaucoma manifests a particular predilection for that race. Brazilian negroes have shown a higher percentage than was found among the whites; and many cases occur among the Egyptians. It is more common in some countries than in others; "Englishmen," according to Maitland Ramsay, "are more commonly affected than Scotchmen. This racial proclivity being in great part dependent on heredity and consanguinity." Mackenzie noted that dark-eyed persons were more prone to glaucoma than those the color of whose iris is blue or gray.

Sex. Females are more susceptible than males, and this greater predisposition pertains to the whole of life. In women, however, the tendency to congestive forms is more marked than for the non-congestive. This extra susceptibility of females is in many cases ultimately connected with the cessation of the menses.

Size of the eye. It is a matter of common observation that patients with primary glaucoma have small corneas, and as the glaucomatous eye is usually hyperopic there seems to be a relation between the smallness of the cornea and glaucoma. Glaucoma is not a disease of small eyes, although small eyes are especially susceptible to primary glaucoma and they appear to be attacked earlier in life than others. Yet they are not the only eyes which suffer, for the disease is met in eyes of average and of more than average size. The average horizontal diameter of the normal cornea is 11.6 mm., but eyes in which the meridian measures only 10 mm. seldom escape glaucoma. The greater susceptibility of small eyes appears to depend on their containing disproportionately large lenses.

The thickness of the scleral tunic is affected by the increase of the contained pressure within the globe, according to Ischreyt, who found the sclera thin in the anterior and equatorial regions in primary glaucoma and commonly so in absolute glaucoma. The posterior half is rarely thinned except as the result of myopia, although the thinning of primary glaucomatous eyes resembles that which is found in hydrophthalmos rather than what is noticed in myopia; and the lengthening of the antero-posterior diameter of a glaucomatous eye depends upon the stretching of the anterior segment of the globe.

Myopic eyes are less frequently the subject of the glaucomatous process, and when they are affected the glaucoma seems to run a slower course, yet there appears to be some antagonism between glaucoma and myopia. Myopia may develop during the course of glaucoma

and when it does, it has been said to have a beneficial effect upon the glaucoma.

Refraction of the eye. Gilbert found among 71 cases of glaucoma at the Munich clinic, 26 per cent. who were either emmetropic or myopic; in 115 inflammatory cases, 77 per cent. were hyperopic, the remainder being equally divided between the emmetropic and the myopic. It is possible, therefore, for the refraction of the eye to influence the form of the disease.

Exciting causes. In patients predisposed to glaucoma the exciting causes of an outburst may be apparently slight. It commonly arises through some disturbance which causes congestion of the head and eyes. As already pointed out, sleeplessness, worry, bronchitis, influenza and neuralgia of the fifth nerve may be charged with producing it.

Changes in the general vascular system. Patients of the age at which primary glaucoma is commonest frequently have degenerated vascular conditions due to some diathesis, as that of gout or syphilis; while others may have marked arteriosclerosis with symptoms of renal insufficiency. While vascular changes are very frequent they are not specific nor characteristic; as most of the individuals are beyond middle life they usually represent only a greater or less degree of arteriosclerosis.

Rohmer has found that arteriosclerosis may produce glaucoma through the obstruction of the outflow through the veins, which obstruction affects the process of osmosis to such an extent as to produce edema of the vitreous. Sclerosis can both diminish and increase the general blood pressure; its effect upon the production of glaucoma is, however, less direct than indirect, that is to say, it is rather through the influence exerted by the modified cardiac and renal functions, as well as by the alterations in the composition of the blood effected through the disturbed innervation of the sympathetic system. Such a general process cannot but be without influence upon the vascular functions of the ocular tissues, and the study of any case demands that the state of the cardio-vascular system must be carefully considered.

Associated with these anatomical defects there is often an abnormally high blood-pressure, indeed, if a number of non-glaucomatous were compared with an equal number of glaucomatous persons, of corresponding ages, it is extremely likely that the blood-pressure in the glaucomatous would be higher, the differences being undoubtedly greater in the congestive types than in the simple non-congestive. It is well known that the intraocular tension, as effected in laboratory experi-

mentation, responds to the variations in the general blood-pressure; it is uncertain, however, whether, in a subject, excitement or emotion can produce variations great enough to cause an outburst of glaucoma, yet undoubted instances have occurred wherein no other factor could be adduced. It must be borne in mind, however, that very many persons with abnormally high blood-pressure are entirely free from glaucoma and that many glaucomatous persons have a low pressure. While it does not follow that a heightened pressure in the general vascular system produces an increase in the intraocular tension, the degenerate condition of the vessels may lead to hemorrhage, arterial and venous. Indeed, as de Schweinitz has so clearly pointed out, arterial degeneration may be responsible in the hemorrhagic forms of glaucoma, and he believes that the higher grades of degeneration may render the prognosis unfavorable and undoubtedly be responsible for the hemorrhage and other complications arising after an otherwise well-performed iridectomy.

In cases where the intraocular tension is so high as 150 mm. Hg., and more, such tension only occurs in patients suffering from high arterial tension, and yet, as pointed out already, high arterial tension alone does not cause glaucoma. It is difficult to distinguish between hemorrhage causing glaucoma and that resulting from it. It is well known that glaucoma may quickly follow injuries, and, in a susceptible person, after an operation performed on the opposite eye; a foreign body on the cornea may be the apparently trivial exciting cause, which excitement in itself has so upset the balance of control in the patient's general system as to derange the circulation in the eye. But it must not be forgotten that this circulatory change, with the consequent increase in tension, does not originate in inflammation, as is shown by the prompt relief obtained by the use of miotics in contracting the pupil. Conversely, certain of the general measures such as rest, warmth, purging, diet, depressant drugs, resorted to for the palliation of chronic glaucoma might be considered as possessing value because of their influence on blood-pressure. It is the constant practice of the writer of this section, learned from Norris, Harlan, Jackson, McClure and others, in the days when the trained fingers applied to the pulse were relied on as the index of the state of the vascular system, to abstract blood from the temple, copiously, and even to advise venesection.

Overuse of eyes. The overuse of ametropic eyes, especially uncorrected hyperopic astigmia, or otherwise improperly corrected eyes, by causing congestion in the uveal tissues, may bring on an attack. This observation was made by Mackenzie so long ago as 1854, when

he mentioned that "overuse of the eyes for near objects" was one of the causes of glaucomatous choroiditis. In a primary attack the initial disturbance is vascular—a pure congestion—yet the congestion affects only the patency of the filtration angle and does no immediate structural damage to the retina. At the time of life at which glaucoma is commonest, the large lens, having lost its elasticity, is pressed upon during accommodation by the contracted ciliary processes with the result that the filtration area becomes compressed.

Improper use of drugs, mydriatics, adrenalin, etc. It is well known that the application of mydriatic solutions, as of atropin and cocain, may light up a severe attack of glaucoma in an eye which has previously shown no signs of the disease. Yet these drugs cannot of themselves excite glaucoma in eyes which are not already predisposed thereto. Gunnufsen, in studying the intraocular pressure in 157 cases of serpent-ulcer of the cornea, records that in every case which had been treated with atropin the tension was above the normal—25 mm. of mercury or more—and it was only among those thus treated that dangerously high tension was found. The peripheral folding and thickening of the iris, together with the narrowing of the perilenticular space which accompany dilatation of the pupil, may be sufficient to block entirely an already narrow filtration angle. It occurs chiefly in elderly persons with shallow-chambered eyes, especially in those in whom there is persistently an increased arterial pressure. In this connection, one must not neglect to instill a miotic, after the employment of a mydriatic as an aid in the diagnosis of obscure cases of glaucoma, as a preventive of continuing dilatation of the pupil.

Cases have been reported in which a striking increase of intraocular tension has followed the use of adrenalin, and its use either alone or in conjunction with eserin and cocaine may not be without danger. De Schweinitz calls attention to the fact that after sympathectomy adrenalin causes marked dilatation of the pupil.

It is known that abnormal chemo-biologic compounds may circulate in the blood, consequently such compounds may of themselves bear some part in the vexed and vexing question of the pathogeny of glaucoma. Kleczkowski claims to have found adrenalin in the blood serum in thirteen cases of glaucoma; and in these cases there was an excessive blood-pressure; other observers, however, obtained negative results in their series of cases. Nevertheless, it is not at all improbable that the instillation of therapeutic solutions of adrenalin into the glaucomatous eye tend to augment the already elevated blood pressure and consequently a greater increase of the intraocular tension also.

Henderson regards glaucoma following the use of mydriatics after

the presbyopic age has been reached, to be an example of the obstructive class of secondary glaucoma, as it is directly induced by the diminished access of the aqueous in the veins, and he further states, that the shallow anterior chamber of old age cannot be considered as a predisposing factor, for if it were, the danger of inducing glaucoma would be equally great, if not greater, in the infantile eye, with its very shallow chamber.

Injuries. Occasionally cases of glaucoma arise as a direct result of the effects of injuries to the body or head, the connection being manifested in subjects predisposed to glaucoma. Such persons may be grouped with those mentioned elsewhere in whom the lodgment of a foreign body upon the cornea has excited an outburst of glaucoma. They are those whose psychic natures are unstable, whose vessels are more or less sclerotic and whose nervous systems are capable of being profoundly depressed by seemingly trivial causes.

Effects of season and climate. It has been stated that acute glaucoma appears to be more frequent in winter than in other seasons of the year, yet it has been the writer's experience to have had each year since 1894, at least one case in midsummer. It is conceivable that the frequent incidence of glaucoma among Europeans in winter, and in the natives of India during the rainy-season, is dependent upon the blood-pressure changes influenced by climatic variations. In direct contrast to the testimony from cold regions is the experience of Lobo, of Bogota, who states that inflammatory glaucoma is very common in the hot Central American countries. He has not found that the subjects have been more susceptible by reason of alcoholism, arteriosclerosis, affections of the heart or by malaria. Sclerosis of the crystalline and the onset of presbyopia are premature in hot countries; these two factors he believes accelerate the development of glaucoma in those whose occupation exposes them to great tropical heat. He found glaucoma in equal frequency in the two sexes in early life, but more frequently in women at about fifty years of age.

The vascular and lymphatic circulation in the eye in connection with glaucoma. It may be well to consider certain aspects of the circulation of the eye in connection with glaucoma, which are here adapted from Fuch's well-known description.

The uvea is very richly supplied with vessels derived from the system of ciliary vessels which has but few anastomoses with the conjunctival vessels at the margin of the cornea, and still fewer with the vascular system of the optic nerve and the retina at the border of the scleral foramen. But within the uvea itself the anastomoses are very abundant. The arteries are connected by two arches, one at the root

of the iris, the other close to the pupillary margin. The veins in the choroid are arranged in whorls or vortices, and the veins belonging to any two adjoining whorls are connected by a series of arched anastomoses. Disturbance of circulation in the choroid can be compensated for much more readily than in the retina, whose vessels possess no anastomotic connections. The vortex veins carry off almost all the blood of the uvea; obstruction of these veins, therefore, leads to serious disturbances of circulation and to increase of tension. The vortex veins are not numerous neither do they present other connections, and, in the region of the equator the blood from the posterior half of the uvea must enter from behind forward. Furthermore, the very oblique direction of their course through comparatively narrow and indistensible canals in the sclera may lead to interference with the discharge of blood from the eye.

The richness of the uvea in vessels in the anterior segment of the eye is of service in the secretion of the aqueous, while in the posterior segment it is of service in the nutrition of the retina, and in the restoration of the visual purple and other visual substances. The arrangement of the choroidal vessels favors these objects; the large vessels are placed farthest from the retina, and therefore retain the nutrient matter, while all the capillaries, lying as close to the retina as possible, are united to form a single layer.

The retina is very poor in vessels, the fovea centralis, the spot that is most important for vision, being entirely destitute. Neither have the retinal vessels anastomoses with each other, and there are no anastomoses worth mentioning between the retinal and ciliary systems of vessels, so that the latter, whose circulatory relations are far more favorable, cannot substitute for the former.

The amount of blood within the eye is subject to a variety of alterations not only in those connected with the blood vessels themselves, but also it is affected by the reactions of the iris and ciliary body as well as by the pressure exerted by the ocular muscles from without.

Circulation of the lymph. The intraocular lymph is generated entirely, or almost entirely, by the ciliary processes, the formation of it being favored by the rich vascular supply and the extensive superficial area of the processes manifested by their foldings and reduplications. The lymph is not secreted in the true physiological sense, for there are no glandular elements inherent in the ciliary body: the lymph is poured out by transudation by a process of filtration.

The lymph for the most part passes forward from the posterior chamber through the pupil into the anterior chamber. The aqueous then passes out of the anterior chamber, through the spaces of Fon-

tana into the anterior ciliary veins by way of Schlemm's canal, through the anterior surface of the iris and through the ciliary body. None can pass through the cornea unless the endothelium of that membrane be destroyed.

The angle of the anterior chamber provides easy filtration, for here the blood vessels are merely endothelial tubes, the walls of which are kept open by being adherent to the sclerotic.

The outflow of fluid from the vitreous is slow under normal pressure. It is probable that under forced pressure, experimentally, the lymph passes out by means of the perivascular sheaths of the central retinal vessels, but during life the fluid passing forwards from the vitreous largely aids in the restoration of the anterior chamber, in the event of a sudden loss of the aqueous by operation, accident or disease.

The perichoroidal space drains into the perivascular lymph spaces around the vortex veins. This portion of the lymph is small in quantity and is not concerned with the maintenance of the intraocular pressure.

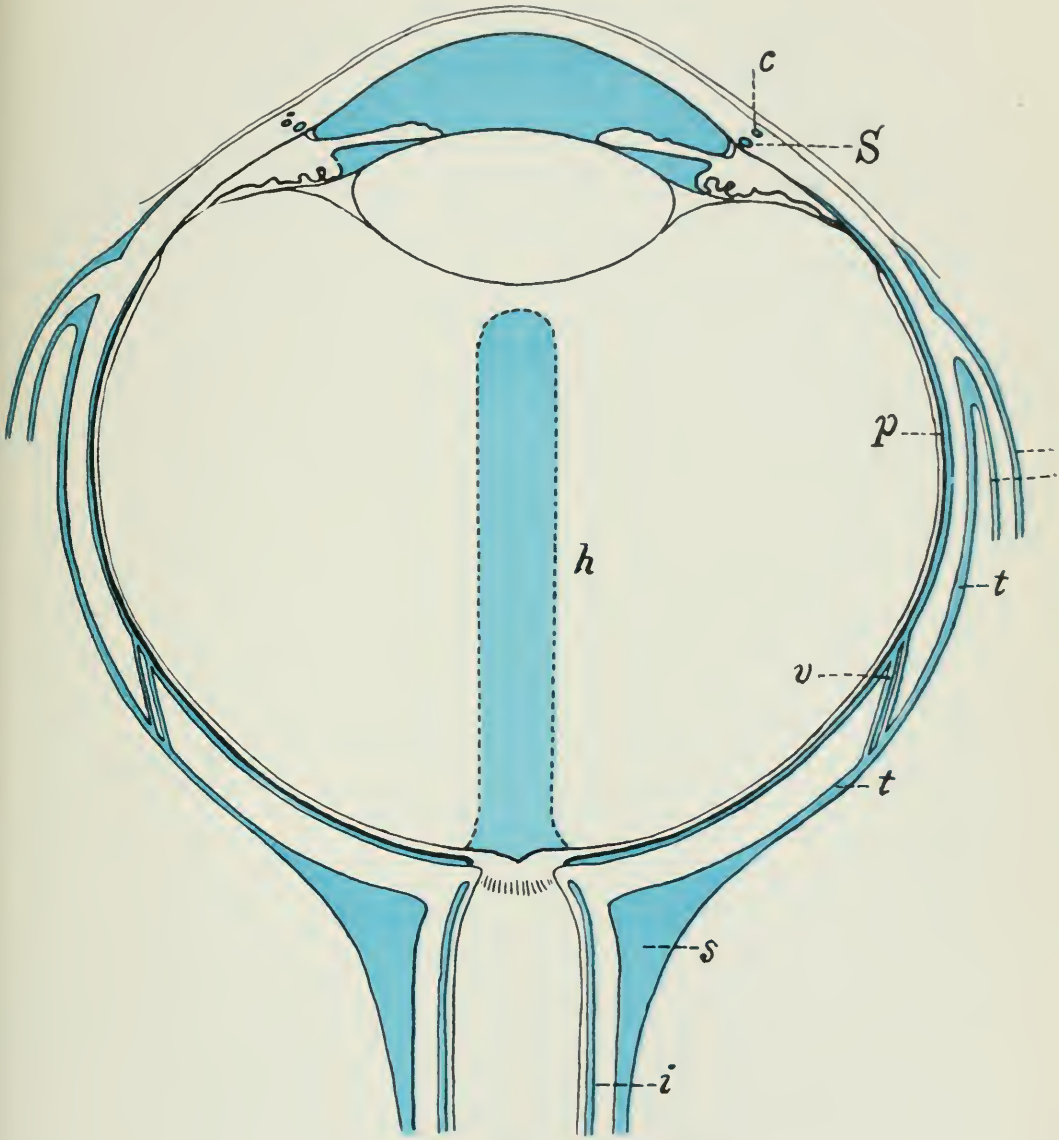
Pathology of glaucoma. The pathology of glaucoma is complex and most obscure. The causative factors adduced, as heretofore stated, are innumerable. Histologically, quite definite changes have been found by several observers, each of whom has ever been ready to support his hypothesis as to the causation of the disease, only to be baffled by the absence of the vaunted changes in his next case. (For a more extended account the reader is referred to Parson's "*Pathology of the Eye.*")

In the acute congestive forms the uveal tract is congested, while in the later stages and in chronic glaucoma there is degeneration. In congestive glaucoma there is marked venous stasis, often with hemorrhages, the tissues are swollen by exudation containing fibrin, leucocytes, red corpuscles, etc. In the subacute and chronic stages degeneration occurs in the iris and ciliary body and in the choroid, which becomes much thinner than normal. Changes are most marked in the vortex veins. The perivascular lymph-spaces and the surrounding sclerotic are densely infiltrated, round and oval cells pervade the vessel walls accompanied by proliferation of the endothelium, yet such changes are frequently found in eyes which are quite free from glaucoma.

In advanced cases of glaucoma the retina becomes atrophic.

In acute glaucoma and in chronic congestive glaucoma a marked displacement of the rods and cones has been noted, together with changes over the whole retina.

The effect of glaucoma upon the optic nerve was recognized by Heinrich Müller as early as 1856. The optic nerve-entrance is the



Lymph Passages of the Eye (Schematic).

S. Schlemm's canal. c. Anterior ciliary veins. h. Hyaloid canal. p. Perichoroidal space, which communicates by means of the venæ vorticosæ, v, with Tenon's space, t.t. s. Supravaginal space. i. Intervaginal space. ee. Continuation of Tenon's capsule upon the tendon of the ocular muscles (lateral invagination). (Fuchs.)

weakest spot in the ocular wall so that increased pressure manifests itself anatomically here sooner than elsewhere. In health the lamina cribrosa passes transversely across the nerve, but very early in glaucoma it assumes a curve with the concavity forwards. As a result of the pressure the fibres in the nerve-head become atrophic and the ganglion cells in the retina from which the fibres spring, undergo degeneration. In the cupping of the disk there is accordingly loss of substance as well as ectasis. As the case advances, the ectasis increases, so that the lamina may extend beyond the level of the sclerotic. The overhanging lip of the cup seen in the ophthalmoscopic picture is really the anterior edge of the scleral foramen, for, in advanced cases, the sclera forms the lateral wall of the cup. The nerve fibres lining the cup become more and more atrophic as time advances, as the field of vision shows, the temporal fibres suffering earliest, and, later on, total atrophy follows. The degeneration in the excised nerve can be demonstrated by appropriate staining methods.

It is generally conceded that the changes in the optic nerve are brought about entirely by the effects of prolonged pressure. Schnabel, however, advanced the view that there is also an active neuritic atrophy, as shown by the formation of new blood-vessels, proliferation of the interstitial connective tissue, etc. He considered that the lamina cribrosa is not pressed back by the increased pressure, but is pulled back by the shrinking connective tissue of the atrophic nerve. From the study of a large number of eyes he came to the following conclusions: Degeneration occurs early in the nerve-fibers, commencing in the intra-scleral part, and soon leads to the formation of microscopic holes which rapidly enlarge, producing a condition which he calls cavernous degeneration. The holes then coalesce into clefts and irregular spaces, and the lamina cribrosa becomes exposed upon the surface anteriorly. Finally a single large cavern, the glaucomatous excavation, results.

The amount of connective tissue on the surface of the lamina cribrosa varies, depending probably upon the condition of the inherent normal connective tissue. In some cases it may be completely absent, while in others the cup may be filled with new-formed connective tissue; it is usually filled with vitreous.

Pressure within the globe tends to cause stretching of the sclerotic and the development of ectasis. In the eyes of the young the sclera may become stretched equally in all directions, so that total ectasis occurs (see **Infantile glaucoma**). In the eyes of the adult, however, the resistance is great enough to prevent stretching in all but the

weakest parts so that the ectasis may be only partial, which may be confined to the ciliary region or to the equatorial. The posterior half of the globe is rarely thinned except as the result of myopia.

The ciliary ectasiæ form bluish bulgings beyond the limbus. These staphylomata consist of the stretched sclera and contain the thinned-out ciliary processes which extend over the inner surface of the ectatic area. Equatorial staphylomata, which are less common, are generally found slightly behind the equator at a weak point in the sclerotic in the neighborhood of a vortex vein. They present a thin membrane, over the inner surface of which is stretched the very much degenerated uvea.

Pathogenesis. Von Graefe, relying at first upon Jaeger's mistaken idea in regard to the appearance of the nerve-head, assuming that what is now known to be an excavation or cupping of the papilla was a globular protrusion, believed in the inflammatory nature of glaucoma and expected to find exudation and vascular dilatation in the optic nerve. And although he very soon afterwards corrected this view, he nevertheless attributed glaucoma to a serous choroiditis, which caused increase in volume of the vitreous and the rise of intraocular pressure with compression of the retina.

"The mystery which continued to surround the causes of the disease long after its dependence on increased pressure had been recognized," writes Priestley Smith, "was due to the lack of knowledge of the processes by which the supply of fluid to the chambers of the eye is maintained and regulated." Through the researches of Leber, we now know that the highly vascular ciliary body is the chief secreting organ of the eye, and that the aqueous chamber is replenished and the vitreous and the lens are nourished by a fluid which is supplied through the medium of the capillaries of the ciliary processes, by a process of transudation from the epithelial surface of the ciliary body. The freshly secreted fluid stands in close osmotic relation with that which is contained within the membranes of the vitreous body. The composition of the aqueous and vitreous fluids therefore are nearly but not quite identical, each containing approximately 95 per cent. water, 1 per cent. salts and extractives and a minute quantity of albumin. The rate of its production depends upon the difference between the pressure of the blood and the pressure of the fluid in the aqueous chamber. Its rate of formation is about 5 c.mm. a minute, so that the whole content of the aqueous chamber is changed in less than one hour.

The fluid passes over the lens and through the pupil into the anterior chamber, passing out through the angle at the junction of the iris

and cornea, thence through the meshes of the cribriform or pectinate ligament, thence by filtration and diffusion through the canal of Schlemm, which is in itself a mere plexus of veins. Some of the fluid is absorbed and eliminated by the iris, but the greater quantity of it passes into the anterior ciliary veins, while only a small portion flows backward through the vitreous to escape by way of the lymph channels in the optic nerve.

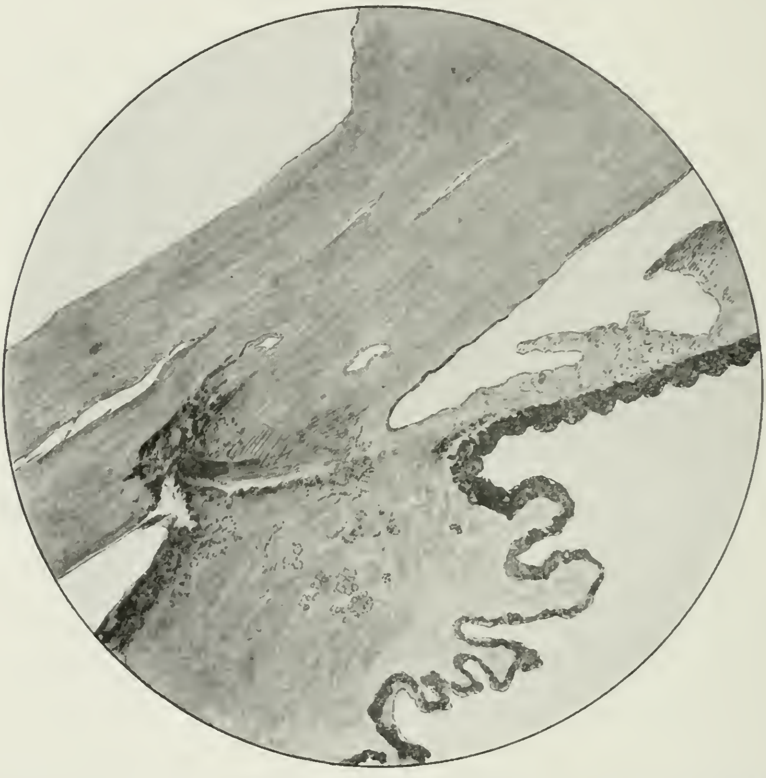
Front of Normal Eyeball to Show the Circumlental Space, X6.
(Maitland Ramsay.)

According to Schoenberg, the ocular drainage in glaucomatous eyes differs from that of normal eyes. The slower the rate of drainage the nearer the eye is to an acute attack or to absolute glaucoma; the more rapid the rate of drainage the nearer to a state of compensated glaucoma. A reduction of the rate of ocular drainage may mean latent glaucoma in spite of an intraocular pressure which is within the normal limit, that is to say, below 26 mm. Hg.

The sympathetic nerve exercises a certain regulating influence over the ocular pressure, for, irritation of the cervical sympathetic increases the pressure, while section of the nerve decreases it. This physiologic demonstration led surgeons to practise sympathectomy for the relief

of glaucomatous pressure, but the results have not been satisfactory because the diminutions have been only transitory.

Parsons declares, however, that the marked rise in the intraocular pressure produced by stimulation of the cervical sympathetic is not due to alteration in the general blood-pressure, but rather to the contraction of the unstriped muscle fibers in the orbit. The influence



The Angle of the Anterior Chamber in a Healthy Eye, showing the Canal of Schlemm, the ligamentum pectinatum, and lymphatic crypts at the periphery of the iris. (After Collins, in Posey and Wright.)

of the nervous system upon the maintenance of the pressure of the fluid in the chambers of the eye is quite indirect.

The maintenance of pressure is derived undoubtedly from the force of the blood-current, and the pressure of it within the chambers regulates the outflow, while, because the intraocular pressure is the same in the vitreous and aqueous chambers, the equilibrium preserves the shape and tension of the eyeball. Thus, again, to quote Priestley

Smith, "When regulation fails and the pressure in the chambers rises above the physiological limits we have the complex disturbance of function and structure called glaucoma."

It has never been satisfactorily determined what the potent factors are in disturbing the regulation of pressure. It is now generally held that, in the main, the disturbance is caused by a retention of the fluids through obstruction to their outflow. Leber demonstrated that the aqueous escaped at the angle of the anterior chamber, and in 1876,

Front of Eyeball to Show the Narrow Circumlental Space in a Glaucomatous Eye, X6. (Maitland Ramsay.)

Knies and Weber showed that the angle is found to be obstructed in eyes blinded by glaucoma through the adhesion of the iris base to the periphery of the cornea, whether through iridocyclitic inflammation or from pressure by a swollen ciliary body. The process therefore rests upon a disturbance of excretion rather than on an increase of secretion.

It is of interest to note that glaucomatous eyes are hard not only at the time of excision but remain hard for a long time afterward, proving that the high tension is dependent upon properties inherent in the globe itself and not governed by heightened blood pressure.

One of the writer's earliest teachers, who had little or no regard for the preservation and histologic study of excised globes, used to demonstrate the hardness by driving the ball to the floor and catching it on the rebound! Major Elliot, however, in disputing the statement of Priestley Smith, reports several cases in which tension was greatly diminished, even to well below the normal, after excision, when measured with the Schiötz tonometer. Priestley Smith commenting upon the results of Elliot, would qualify his statement by

Normal Corneo-iridic Angle, X30. (Maitland Ramsay.)

saying that while non-glaucomatous globes soon begin to collapse, glaucomatous eyes remain comparatively full, showing no collapse even after several hours, because they have parted with less fluid: and he recalls Leber and Benzen's testing of excised glaucomatous eyes in which it was found that they permitted little or no filtration: clear evidence of changes which check the escape of fluid from the chambers.

As already mentioned, the increase of susceptibility as the years progress depends upon the continuous growth of the crystalline lens. While the cornea and globe in general attain their maximum growth in early adult years, the lens continues to grow from youth to old age.

According to Priestley Smith, during the forty years between 25 and 65 the lens adds one-tenth to its diameter and one-third to its volume. Consequently the space between the lens margin and the surrounding structures is encroached upon by the growing lens; yet as the lens grows larger the globe itself does not increase in size. It is a common experience to find glaucoma in small eyes. In the hyperopic eye the ciliary area is usually small, and, from turgescence of the ciliary processes during the excessive strain attending accommodation, the iris

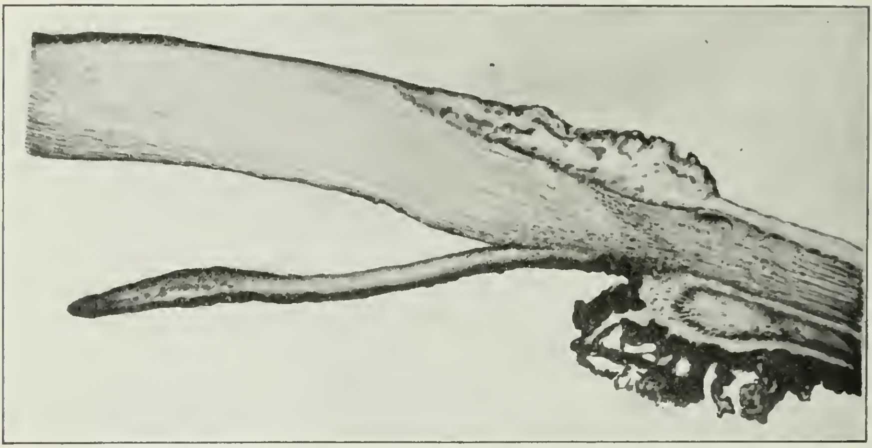
To Show the Blocking of the Corneo-iridic Angle in Glaucoma, X30. (Maitland Ramsay.)

base is pressed upon and the filtration angle is compressed, with the result that the outlet is blocked. Contact of the iris without compression does not necessarily shut off the aqueous from the ligament and Schlemm's canal, but when the turgid processes are compressed between the lens and the iris, the fluid which they secrete into the vitreous is unable to find an exit.

It is possible that hypersecretion is sometimes concerned in the onset of glaucoma, or that the character of the fluid is changed so that it becomes serous, as has been noted in many instances by the presence of coagulated albumin deposited on the hyaloid membrane.

Yet, the accumulation of the fluid behind the lens seems to be due to the obstruction of the circumlental space by the swollen ciliary processes, rather than to excessive secretion.

The observations of Priestley Smith only support the earlier contention of Weber that primary glaucoma depends on the closure of the filtration angle, from changes in the shape and position of the ciliary processes and of the lens, and that in some stage of the process the iris is brought into contact with the cribriform ligament and becomes adherent to it, while the iris itself, in the meantime, is more or less compressed between the ligament and the ciliary body.

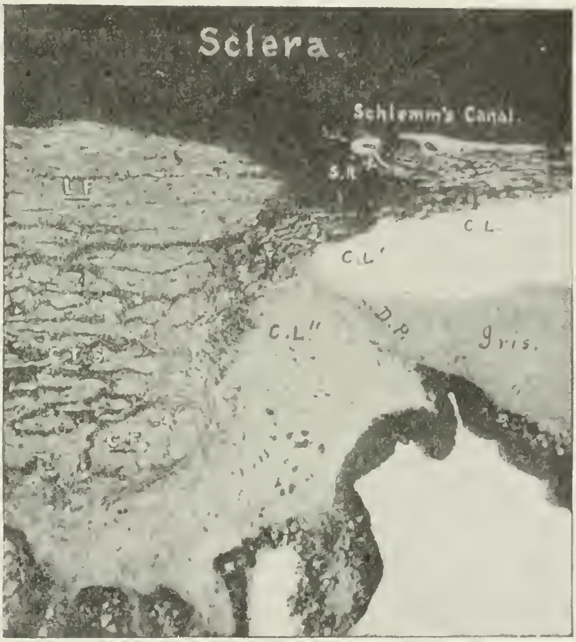


The Angle of the Anterior Chamber in a Case of Primary Glaucoma, showing closure of the filtration area at the periphery of the cornea, by apposition with it of the root of the iris. (After Collins, in Posey and Wright.)

As the ciliary processes are usually altered both in size and position, Hess observes that individual differences in the form of the ciliary body are as important in the consideration of the causation of glaucoma as are the variations in the size of the lens, because he has demonstrated that during life bulbous outgrowths may develop on the ciliary processes. The part therefore played by the ciliary body may not be inconsiderable, because through the atrophy of it the processes, the zonula, the lens and the iris are gradually brought nearer the cornea. Hess noted that not infrequently the iris near its root is twice as thick in the eyes of old people as in those of infants.

It is unfortunate that we can seldom study the early stages of the disease under the microscope, for the eyes are commonly saved in that stage by operation. The histologic studies consequently have been of eyes that have been long diseased and even atrophic, and, as

the preparation of an eye for microscopic study must necessarily disarrange the tissues, the certainty of the conclusions must be much affected. So, too, different parts, when studied by various authors, have been found to be prominently affected; as, for instance, Brailey described a chronic inflammation of the ciliary processes with distension of the vessels, which he considered were the primary lesions



Micro-Photograph of the Cribriform Ligament.

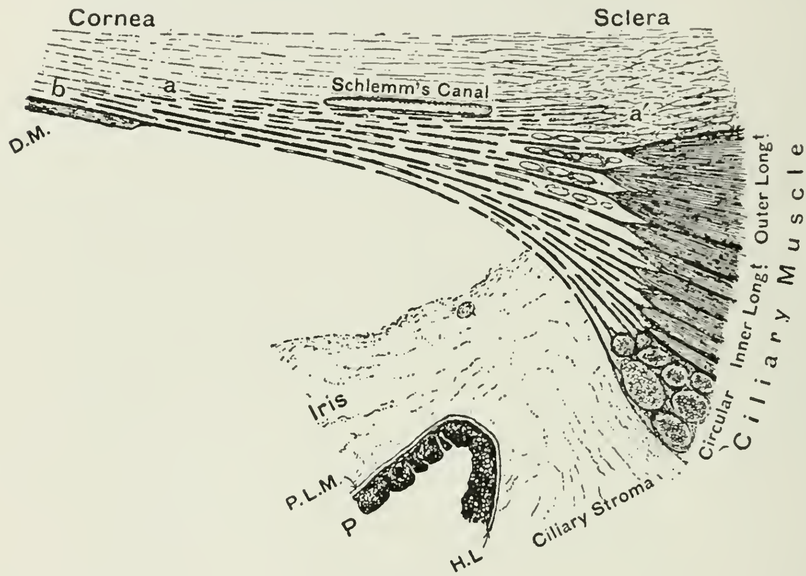
A man aged sixty years. Eye fixed in formalin. Van Gieson's connective-tissue stain. There is marked and complete sclerosis of the fibres composing the cribriform ligament (C. L.). At C. L. the fibres lie on the inner side of the scleral ring (S. R.), and terminate (C. L.) by being incorporated into the connective-tissue stroma (C. T. S.), here markedly sclerosed, of the circular fibres (C. F.) of the ciliary muscle.

L. F., Longitudinal fibres of the ciliary muscle. D. P., Fibres of origin of a fasciculus of the musculus dilator pupillae. X, Posterior extremity of Schlemm's canal, into which opens a direct tributary from the ciliary venous plexus which has made its way along the fibres of the cribriform ligament internal to the scleral ring. (Thomson Henderson.)

in glaucoma; Laqueur and others believe that the rigid sclerotic coat hinders the flow of the currents of the lymphatics, while Stilling believed the hardening of the sclera in the region of the papilla obstructed the escape of the fluid from the vitreous and thus led to glaucoma.

According to those who hold that the cause of glaucoma depends upon an interference with the escape of fluids through the spaces in the posterior part of the eye or through both these exits, an accumulation of the fluids is facilitated and through such accumulation the intraocular tension rises and glaucoma supervenes. Hence, upon the increased tension depend all the disturbances in the eye in this disease.

Other observers reject "retention theories." They hold that such hypotheses do not explain the origin of simple glaucoma, because in this



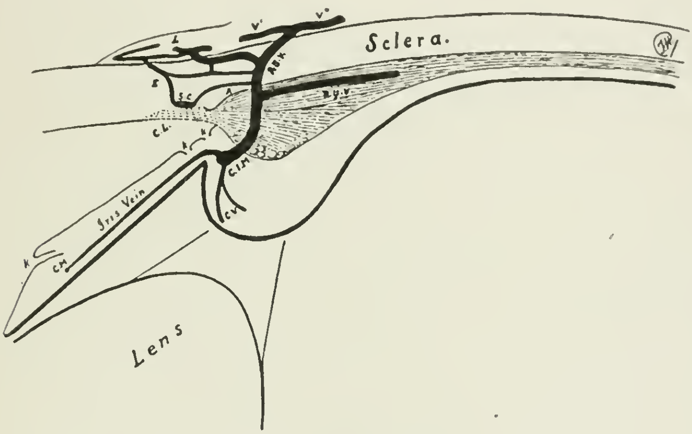
The Cribriform Ligament.

The inner lamella of the Cornea (a and b) are continuous with the fibres of the Cribriform Ligament. The outer fibres, which start from *a*, lie next to Schlemm's Canal, and terminate at *a* in the scleral fibres. The inner fibres, which start from *b*, spread out in a fan-shaped manner to act as fibres of origin to the longitudinal muscle bundles and as check fibres to the circular bundles of the ciliary muscle. The pigment epithelium (P) and posterior limiting membrane (P.L.M.) of the iris and continuous with the respective pigment and hyaline layers (H.L.) of the ciliary body. Descemet's membrane (D.M.). (Thomson Henderson.)

form of the affection there is not usually a marked increase of tension. Neither can it be constantly proved, they say, that congestive glaucoma arises through the adhesion of the iris base with the blocking of Fontana's space, for they believe these phenomena may be the result of increased tension, and it cannot yet be shown that they are always present in the early stages of the disease.

Von Graefe thought that glaucoma was a manifestation of choroid-

itis; Wahlfors, and other more recent observers, hold that the primary lesion is an atrophic process in the chorio-capillaris, believing that the excavation of the nerve head, with the consequent defects in the visual perception, are dependent upon nutritional changes in the layers of rods and cones. The increase of tension is by them explained on the assumption that the slowing of the current of the intraocular fluids depends upon a paralysis of the muscular network of the choroid, through which the retarding of the current permits the deposition of formed elements in the exit-channels with consequent



The Iris Venous Return.

The Circulus Iridis Major (C.I.M.) is formed by the Iris Veins though also receiving tributaries from Ciliary Veins (C.V.). Before piercing the Sclera, it gives off a branch to the posterior uveal venous system (P.U.V.), and then it pierces the sclera (A.U.V.) to take part in the anterior uveal venous (see the figure following). The main trunk supplies afferent tributaries (A) to Schlemm's canal, as well as other branches which join the superficial plexus (L) in the limbus. On the surface the trunk invariably divides into anterior and posterior branches (V' and V''). The efferent vessel (E) from Schlemm's canal (S.C.) is closely associated with the superficial pericorneal plexus (L). The cribriform ligament (C.L.) and iris crypts (K) lead the aqueous respectively to Schlemm's canal and the iris veins. (Thomson Henderson.)

retention of the fluid; the venæ vorticosæ, meanwhile, are compressed by the increased tension and stasis follows.

Knies and others advance the hypothesis that the process is really a strange disease of the optic nerve. Donders believed simple chronic glaucoma to be due to innervational disturbances; and certain more recent investigators incline to separate it from glaucoma altogether and place it among the diseases of the optic nerve. Others still regard it as a neuritis which blocks the lymph channels in the optic nerve, whereby drainage is prevented and the retention of effete materials

causes the increase of tension with the excavation of the nerve head. By those observers this form of the disease is spoken of as "posterior glaucoma."

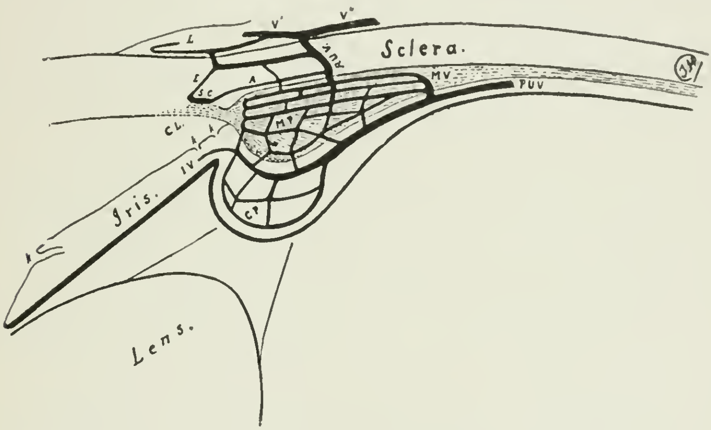
Zimmerman and others believe that the primary cause depends upon a difference between the general blood-pressure and that of the eye. But high pressure in the radials does not necessarily imply high pressure in the ciliary capillaries, and as a matter of fact the very high blood-pressure met with so frequently in arteriosclerosis and in interstitial nephritis are not commonly associated with an increase of intraocular pressure.

Uribe-Troncoso, of Mexico, found in the aqueous humor of glaucomatous eyes an increase in the normal amount of albumin, and he adduced from his findings the hypothesis that the symptoms are caused by the presence of albumin. The albumin exudes through the diseased blood vessels, and the alterations noted as present in the vitreous are not without their influence. It is probable that the process of osmosis is materially affected by the composition of the fluids and by variations in the degree of intraocular tension, yet there is no proof that chronic glaucoma originates in an altered aqueous fluid. However, as his cases were of the congestive type in which serosity of the aqueous is a natural result of the high tension and obstructed circulation, the presence of albumin is to be expected and his results do not shed much light on the initial causes of glaucoma. It is none the less true that solid particles, as of pigment after intraocular hemorrhage (Levinsohn), and tumor cells (Verhoeff), becoming caught in the meshes of the filtration space, may cause glaucoma.

Thomson Henderson, as the result of an examination of several thousand sections, came to the conclusion that the old term ligamentum pectinatum iridis is inappropriate. He found that this so-called ligament is derived from the innermost corneal fibers which end, not in the iris root as was formerly thought, but at the ligament of origin of the ciliary muscle, and he suggests, therefore, that a better name would be the "cribriform ligament." Seeking to establish the circulatory nature of the intraocular pressure he conducted a most extensive study of the pathogenesis of primary glaucoma, and, in 1907, he announced that glaucoma depends upon obstruction and closure of the filtration area as the result of sclerosis of the fibrous structures comprising the cribriform or pectinate ligament, which impedes the access of the aqueous humor to Schlemm's canal.

The ligament, as Henderson defines it, is nothing more than a regular open network of interlacing fibers which are in direct continuation with the circular and longitudinal bundles of the sclera around the

venous sinus of Schlemm's canal. The ligament is pulled taut and its alveoli opened when the ciliary muscle contracts. The constant contractions of the ciliary muscle induces a progressive sclerosis of the cribriform ligament with the result that the interspaces and alveoli are reduced in size and the ready access of aqueous to Schlemm's canal is thus seriously impeded: therefore, the adult eye is predisposed to glaucoma. He maintains that it is not the iris which is pushed forward by the ciliary processes; on the contrary, it is the ciliary processes which are dragged forward by the iris. The consequences of such



The Ciliary Venous Return.

The Ciliary Plexus (C.P.) is closely associated with Iris Veins (I.V.) and with the Muscular Plexus (M.P. and M.V.) in forming branches (P.U.V.) which join the posterior uveal veins or venae vorticosæ. Anteriorly piercing the sclera about the pericorneal circumference are the anterior uveal veins, which derive their blood directly from the whole of the ciliary muscle plexus (M.P. and M.V.).

The main vessels, as they pass through the sclera, all communicate with Schlemm's canal either directly or indirectly and on the surface break up into anterior and posterior branches (V′ and V′′). The former join the superficial pericorneal plexus (L) of the limbus. The ciliary venous return in its passage through the sclera is thus closely linked with the iris venous return (see preceding figure) to form an anterior uveal venous system. (Thomson Henderson.)

occlusions are, first, a diminution and, later, a complete obstruction of the outflow. The iris through the medium of the crypts remains as the only channel for the passage of the lymph. He holds that the intraocular pressure is vascular in origin and nature, and stands and varies with the intraocular venous pressure, and is not the product of a balance between inflow and outflow of aqueous. As a secondary, but less dependable, cause, is a disturbance in the vascular mechanism, the excitation of which gives rise to the attacks of increased tension.

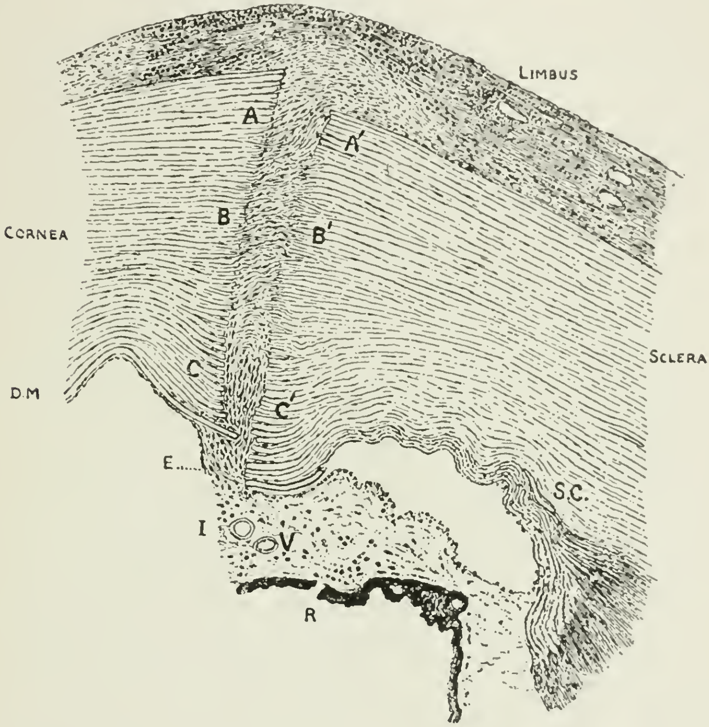
He declares that in acute congestive glaucoma the vascular element predominates; in chronic non-congestive glaucoma, it plays an altogether insubordinate and inconspicuous part. But such an hypothesis does not account for the shallowness of the anterior chamber which decreases in depth, as the disease progresses, nor for the progressive closure of the filtration angle. Henderson concludes by stating that glaucoma can be produced only by the combination of two factors, neither of which alone can produce it—an increase of the intravenous pressure and the sclerosis of the cribriform ligament which raises a mechanical obstruction to the free access of aqueous to Schlemm's canal. A mechanical obstruction such as he defines cannot be otherwise in effect than a retention; and, if sclerosis is the invariable process as age advances, how is it that glaucoma is not found in every aged person? So, too, only a small proportion of the senile with high blood-pressure develop glaucoma, and further, if the two factors mentioned are essential for the production of glaucoma, how is it that one so often sees glaucoma in comparatively young persons? As sclerosis has been found in secondary as well as in primary glaucoma, it is more than probable, as Verhoeff suggests, that the sclerosis of the pectinate ligament occurs as a consequence of iris adhesion.

The contribution offered by a consideration of the effects of palliative, if not curative, operative and medicinal procedures is not without value and importance.

The action of miotics is accounted for upon the supposition that by the contraction of the pupil the iris is stretched in a radial direction, and is drawn away from the wall of the eyeball to which it has been applied, so that the sinus of the chamber again becomes free—and, according to Henderson, the iris crypts are opened out and the passage of the aqueous to the iris veins is facilitated.

The hypothesis of Fischer (*Pflüger's Archiv f. Physiol.* vol. 127, 1909) has attracted numerous adherents. It consists in the belief that glaucoma depends upon an edema of the eyeball, in which the hydrophilic colloids of the eye retain an increased amount of water. In his opinion the exciting causes of glaucoma are such as lead to an abnormal production or to the increased accumulation of acid in the eye, and further, that the hydrophilism depends upon the presence of the acid. Ruben found that the vitreous was not hydrophilic, neither did it swell by the action of the acids, but the cornea and sclera became enormously swollen and thickened and thus reduced the volume of the cavity of the eye. Yet, in cases of glaucoma he did not succeed in reducing the tension by injections of sodium citrate, introduced beneath the conjunctiva; nevertheless, he supports Fischer's premise.

As Fischer's hypothesis required a consecutive plan of treatment, his method may, in effect, substantiate the claims of those who regard "toxic acidosis" to be the cause of glaucoma. Rectal injections of hypertonic sodium chlorid solutions are given, combined with subconjunctival injections of solutions of sodium citrate.

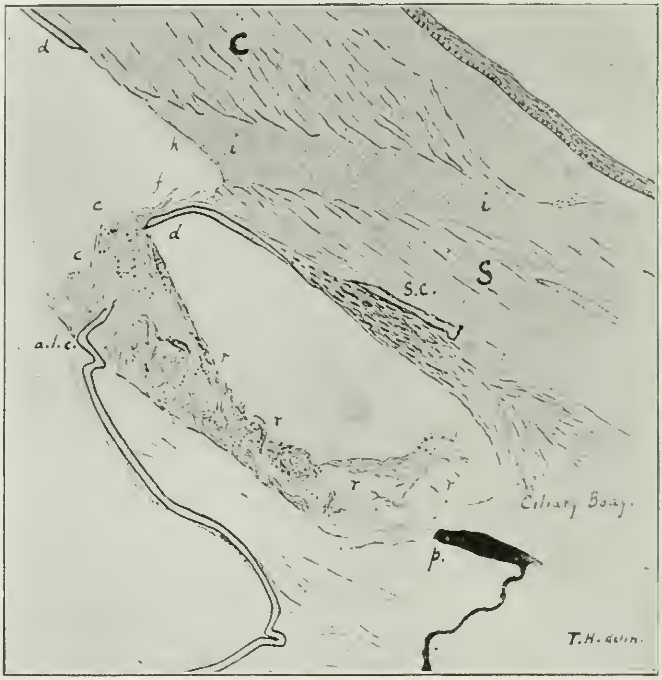


Iridectomy Stump after Extraction. Post-Mortem Case; Date Unknown.

The Incision (A.B.C.) is not completely cicatrized. There is in this section an adhesion of the iris (I), the cut surface of which manifests no reparative changes. Iris veins (V) in cross-section; there is a rent (R) in the posterior pigment layers. Descemet's membrane (D.M.), with its endothelium (E), which has relined the inner extremity of the incision, but stops short at the raw iris surface. (Thomson Henderson.)

The reason why iridectomy diminishes tension has not been discovered so far; it is quite as obscure as the cause of the increase of tension. It is, however, a well-established fact that the tension of a normal eye is not diminished by an iridectomy. Von Graefe was of the opinion that the size of the piece of iris excised had a direct relation to the effect produced, for he believed that the diminution of the intraocular pressure by iridectomy was due largely to the lessening of iris surface

secreting the aqueous humor. And Sir William Bowman, commenting upon this, stated his opinion to be that the more direct communication opened between the vitreous and aqueous regions of the eye facilitated the play of currents between them and thus allowed an excess of fluid behind to come forward to the corneal surface through which exosmosis is much easier than through the posterior coats.



Iridectomy Stump after Graefe's Extraction. Case of Professor Fuchs; Date Unknown.

The incision (*i*) has healed with the interposition of a large intercalary mass between the corneal (C) and the scleral (S) margins of the wound.

The iris stump is denuded altogether of the posterior pigment *(p)*, and shows numerous rents and lacerations (*r*).

The cut surface (*c*) shows no cicatrization; at *j* there is an attachment of iris to Descemet's membrane *(d)*.

The remnant of the anterior lens capsule (a.l.c.) is adherent to the iris stump. (Thomson Henderson.)

Henderson claims that the aqueous is absorbed into the iris veins, and he declares that glaucoma follows from diminished access of the aqueous to the veins, resulting in the conversion of the intraocular circulation into a rigid system. Therefore, treatment to be effective must facilitate the passage of the aqueous to the veins and so restore the circulation to its normal elastic nature. He further claims that

iris wounds do not cicatrize and that therefore the beneficial results of iridectomy follow in consequence of the raw edges of the coloboma permitting access of the aqueous to the iris veins. The miotic drugs, by contracting the pupil open out the iris crypts and act in the same manner. Yet, it is well known that iridectomy and miotics cannot influence the normal intraocular pressure as such already represents the lowest circulatory pressure in the eye and further contact between aqueous and veins cannot reduce it below this level.

De Wecker expressed the opinion that in iridectomy the section in the sclera was of greater importance than the excision of the iris, from his belief that the scleral cicatrix allowed the fluid to filter through it. The operative procedures recently devised by Lagrange, Herbert, Elliot and others are designed to combine the effects of a filtering scar with those of iridectomy. It is still too soon to maintain that the scar remaining after these operations will continue to act as a filter. Probably the thin covering of the sclero-corneal wound is elastic and yields somewhat to an occasional rise of intraocular pressure.

Alt appositely offers "that the excision of a piece of iris of sufficient size is the main part of a glaucoma operation. To this may be added a certain amount of reopening of the filtration angle, if only in parts, during the execution of the iridectomy; perhaps, by the direct pull on the iris by which a part of the peripheral iris adhesion may be loosened. The iridectomy, therefore, instead of opening up new filtration ways, reduces in reality the secretion of fluids or alters their composition." We are accordingly today not far removed from the position held by von Graefe in 1857! Yet it is probably true that operations on the anterior segment of the globe really place the anterior chamber in communication with the supra-choroidal space and thereby open up a path for excretion from both the anterior and posterior segments.

In conclusion, it is not improbable, as Edward Jackson has said, "that the formation of new vessels at the site of the operations has much to do with the reëstablishment of the connections between the interior of the eye and the canal of Schlemm, by the formation of new venous channels of outflow which permit the intraocular pressure to drop nearer to the venous pressure of the body."

The subject remains in an unsettled state, and, as can be seen, the number of the hypotheses advanced for the explanation of the nature and the seat of glaucoma is almost infinite, yet while the lines of inquiry are clearly marked out, no single one of them can explain all cases. "The possible causes as we have seen are many and it is

likely that every possible cause is sometimes the actual cause." (Priestley Smith.)

The hypotheses cited above, however, fairly well outline the paths pursued by the most careful observers. The differences of opinion which the investigations have evoked may be taken as the measure of the intrinsic difficulty attending the subject. Only one thing seems to become more and more certain—that is, that a pathologic process, in general, perhaps, but surely in the intraocular blood vessels, is directly responsible for the glaucomatous state (Alt). We are still without any definite key to the explanation of the extraordinary process which gives rise to the increase of intraocular pressure. It is to pathological physiology that we must turn for an explanation of this disease.

Proper Method of Determining the Finger Tension of the Eyeball.

Diagnosis of glaucoma in general. The importance of the early recognition of glaucoma cannot be over-estimated. The diagnosis is based upon the existence of the cardinal symptom, the increase of tension as demonstrated by palpation with the finger or by means of the tonometer. The most usual premonitory symptoms are the frequent desire to change the reading-glasses, periodical obscuration of vision, and the appearance of halos about lights.

See **Examination of the eye,** p. 4629, Vol. VI, of this *Encyclopedia.*

The attack may be mistaken for cold in the eyes, for iritis, for neuralgia and reflex ocular pains. The condition of the pupil, the diminished depth of the anterior chamber, and the increased tension of the globe are symptoms which should prevent so disastrous a mistake.

The *diagnosis of chronic glaucoma* depends upon the contraction of the field, the increase of tension and the cupping of the disk. It is sometimes difficult to distinguish chronic glaucoma from simple optic

atrophy, especially when there is not a decided increase in the tension, or other marked symptom. In glaucoma there may have been a history of rainbow-vision, in optic atrophy the central and color visual defects are greater and the peripheral contractions are not so closely related to the blind-spot. Of course the intraocular tension is not increased in the atrophic cases, and there is less deep cupping of the disk.

The differential diagnosis between simple glaucoma and the amblyopia caused by simple atrophy of the optic nerve may be sometimes difficult, especially as there are cases of glaucoma in which there is no appreciable increase of the intraocular tension, and in which the excavation of the optic disk is only partial. The observation of the progress of the disease alone is decisive; the diagnosis of glaucoma can never be made by the ophthalmoscopic examination alone. When unusually deep and broad physiological excavations are discovered in persons of advancing years, with the general characteristics predisposing to glaucoma, the fields of vision should be studied carefully in spite of the absence of any of the classical symptoms of glaucoma. It must be borne in mind that cases of undoubted glaucoma may go on for years with the intraocular tension much of the time not in excess of the normal. In such cases the data obtained by tonometric examinations is of the greatest importance, and, in the further study of any case the state of the patient's pulse-tension should be measured by the sphygmomanometer and the information obtained duly considered. The study of the visual fields ought to be of service. In simple atrophy, even in the early stages, the color-sense may be considerably diminished so that the fields for red and green are markedly deficient; while in glaucoma, the color fields and the form fields are correspondingly contracted. The shape of the fields and the character of the scotomata are of special interest.

Seidel's observations in imperfectly-marked cases, when studied by Bjerrum's method of perimetry, led him to conclude that an early glaucoma may show merely a pallor of the disk without excavation, and yet, cases of advanced glaucoma may show a pale disk without a typical excavation extending to the margins; and, some cases of so-called primary atrophy, with a deep physiological cup, may be indeed glaucoma, especially if there can be assigned no cause for atrophy.

The condition of the color-sense will remain normal and the light-sense will be retained when the integrity of the optic nerve has been preserved. The study of the light-sense will be of service. In optic nerve atrophy the light-sense from the first may be much reduced, although the ability to distinguish between different degrees of inten-

sity may not be much affected until later. In glaucoma the reduction of the light-sense may be an early symptom; indeed, it may exist for many years before its true nature has been understood; night-blindness may be the first symptom complained of. This early diminution bears no relation to loss of central visual acuity nor to the retraction of the visual field, although it is dependent upon the state of the ocular tension. The later and absolute loss is noted when positive changes in the disk's surface have occurred and therefore marked contractions of the field have taken place owing to the accompanying optic atrophy.

Most unfortunate mistakes have occurred when glaucoma has been taken for cataract. The progressive failure of sight unaccompanied by pain, in an elderly person has often been allowed to go without attention with the expectation of the "ripening" of a cataract which never existed. Here the ophthalmoscopic examination would have decided the case at once.

[As is well known, it is often difficult to decide whether one has to deal with a case likely to pass into a glaucomatous state that will go from bad to worse unless operated on. In such cases the Editor has been in the habit of employing Edward Jackson's test of instilling into the suspected eye one or two drops of a mixture containing a 2 per cent. solution, each, of euphthalmin and cocaine. When the pupil is fully dilated if the tension is palpably increased and the retinal arteries pulsate the verdict should be in favor of operation.

It also throws some light on the outcome of an operation when the action of eserine is observed; should that drug bring about a considerable contraction of the pupil, followed by reduction in tension and the relief of symptoms, it argues in favor of an iridectomy or other operation.

Sym (*Diseases and Injuries of the Eye*, p. 302) condemns the use of homatropin as an aid to the diagnosis of doubtful cases of glaucoma. Dunn (*Lancet*, Aug. 2, p. 352, 1912) considers cocaine a much safer mydriatic for use under such circumstances. Stevenson (*Ophthalmoscope*, Vol. II, p. 73, 1913) records the case of a young adult in whose eye an attack of glaucoma was set up by the use of homatropin to allay the irritation which followed a slight injury. Elliot (*Ophthalmoscope*, Vol. II, p. 58, 1913) has used homatropin for many years as an adjuvant in the diagnosis of obscure cases of glaucoma with hazy cornea, etc. He has never seen the least harm follow, but insists that the patient must not be lost sight of until after the mydriasis has been turned into miosis by the use of eserin; this takes less than half an hour to do.]

Prognosis. The prognosis of glaucoma depends upon the type of

the disease as well as the stage through which it is passing, yet all forms end in blindness if unchecked by treatment, for none tends to a spontaneous cure. Primary acute glaucoma is remarkably amenable to treatment by iridectomy, and it has been said that the more acute the attack the better the prognosis. When in uncomplicated acute cases technically correct operative procedures can be pursued, it is likely that the vision can be largely restored. In chronic cases much depends upon the state of the eye, especially as to the changes apparent in the papilla, and the condition of the iris, as well as the state of the vision, both central and peripheral. There are some cases which can be treated successfully without operation, and there are many in which certain auxiliary measures are of great value. In general, it may be taken as a favorable sign when the differential light-sense rises on the instillation of miotics; it is positively hopeful if the light-sense is restored by operative procedures, but the prognosis must be guarded when the light-sense has not been restored on the reduction of tension.

Seidel found the small isolated scotomata, which he was able to map out by Bjerrum's method as well as the ordinary Bjerrum scotomata, to have entirely disappeared after measures were taken to reduce the intraocular tension. The ring-scotomata of Bjerrum are, he believes, in some cases dependent upon reduction of the pressure, but he noted a reappearance on the resumption of the tension.

The general condition, and especially the nervous system, should be thoroughly investigated. The course varies according as the predominating element in a patient's diathesis is either neuropathic, arteriosclerotic, or both nervous and vascular. A calm, placid nature, bearing the burdens of life during advancing years with equanimity, may hope for a restoration of useful sight more reasonably than a high-strung, neurotic individual with rapid and tense radials. In cases where the pulse tension is continuously elevated both the course of the disease and the probable outcome of surgical interference are less hopeful than in cases of low tension.

Iridectomy cannot be depended upon to afford relief in chronic glaucoma. It fails because the obstruction at the filtration angle is due to firm fibrous adhesions of the root of the iris to the corneosclera, and the operation fails to restore the permeability of these tissues.

It is the hope of the advocates of the more recently devised operations that a greater amount of vision shall be retained by their execution than has always followed after the ordinary iridectomy.

Visual tests must be made frequently, and the refraction measured repeatedly. A progressive narrowing of the peripheral fields, espe-

cially when the macular region is encroached upon, makes the prognosis particularly gloomy.

SECONDARY GLAUCOMA.

The term "secondary glaucoma" is applied to the group of symptoms associated with hardening of the eye-ball, when that hardening occurs as the sequel of preëxisting ocular disease. It may appear as a simple or inflammatory glaucoma, the clinical picture varying according to the disease which it accompanies, and the anatomic changes, therefore, vary greatly according to the diversity in the nature of the cases. And, just as in the case of primary glaucoma, the secondary form may arise in any eye in which there are no discoverable signs of a predisposition to the development of glaucoma. It is especially prone to follow on disease of the uveal tract, particularly of the anterior segment. It is therefore found in ectasias of the cornea with incarcerations of the iris, after incarcerations of the iris in cicatrices in the cornea and sclera; iridocyclitis with deposits in the aqueous and on the layer of Descemet; adhesion of the iris to the lens by the entire pupillary circle; affections of the crystalline lens, as of luxation with swelling of the lens, especially when the lens has been wholly dislodged into the anterior chamber; sudden swelling of the lens after injury or operation. It arises quite constantly in the course of intraocular tumors, as the sarcomata and gliomata, and follows intraocular hemorrhage, and especially in cases of thrombosis of the central retinal veins. Shumway has reported a case of glaucoma arising in a young person with interstitial keratitis, who had used solutions of atropin for six years.

The *pathogenesis of secondary glaucoma* depends entirely upon the obstruction and the retention of the outflow of the intraocular fluid which arise in the course of diseases of the eye and as a consequence of the primary disease. Here the increase of tension follows, therefore, as a complication of an already existing affection, and it entails the same results as augmented pressure does in the case of primary glaucoma. So, also, just as in primary glaucoma, does the adhesion of the iris base to the cornea bring about changes entirely comparable to those seen in inflammatory glaucoma. In some cases glaucoma may be manifested only by an increase of tension with hardening of the globe and the consequent excavation of the optic nerve head, together with disturbance of sight and contraction of the field of vision. Its termination in blindness and degeneration of the eyeball is the same as in primary glaucoma.

Secondary glaucoma is met with at all ages, although undoubtedly

more is required to set it up in young eyes than in old. The vision, too, does not appear to be so rapidly nor so permanently interfered with by the increased tension in young eyes. Removal of the cause too is more certain to arrest the glaucomatous process.

Glaucoma Secondary to Traumatic Dislocation of the Lens. (After Collins, in Posey and Wright.)

It will be well to give a brief account of the chief causes of secondary glaucoma, and to explain the manner of the production of increased pressure in the several forms.

In the adhesion of the iris to the lens by the entire pupillary circle, or annular posterior synechia, the posterior chamber is cut off, and the aqueous is unable to pass through the pupil (seclusion of the pupil), but is held back behind the iris, which becomes bulged for-

ward (iris bombé). The tension consequently rises, and, if it is not relieved, the periphery of the iris becomes opposed to the cornea and may later become adherent to it. If, however, an opening is made in the iris in the early stage, the iris retreats, the angle is reopened, and the tension again becomes normal. If the tension has persisted for a considerable period, the ciliary body may be so much injured as to

Section through the Center of the Coloboma in an Eye which had had an Iridectomy Performed for Glaucoma of two months' standing. (After Collins, in Posey and Wright.)

impair the secretory functions so that after the operation the tension is found to be subnormal. If it has persisted still longer, lymph accumulates in the vitreous chamber and the sequelæ of glaucoma ensue. Only a wide and peripheral iridectomy can afford relief by opening the occluded angle.

Glaucoma may ensue on the perforation of the cornea by a wound or as the result of ulceration from the incarceration of the iris in the

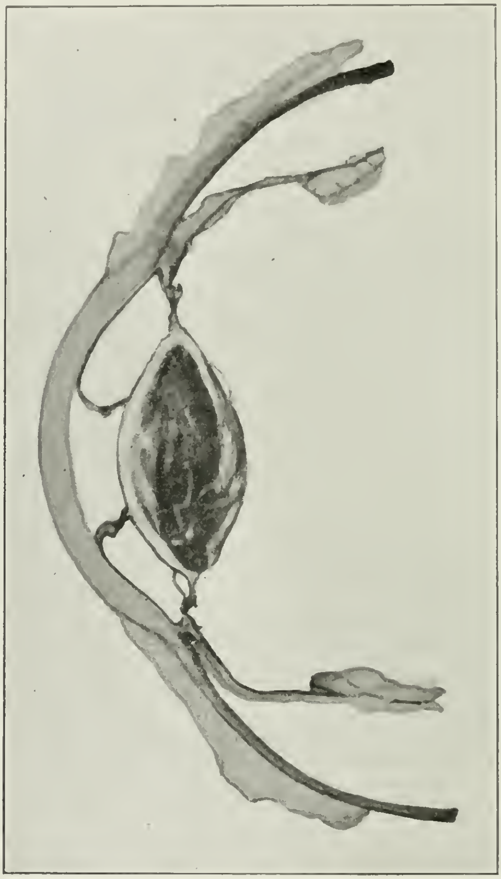
cicatrix, because of the likelihood of obstruction ensuing in the filtration angle. A small prolapse of the iris may at first only partially close the angle which, later on, may become permanently obliterated through the development of a plastic iritis. Central ulcerations, also, may lead to the adhesion of the lens and iris to the cornea, the anterior chamber being abolished when the lens is pushed forward and becomes agglutinated to the cornea. Such a condition may persist, especially when the lens has been wounded.

Increase of intraocular pressure may develop in ectasis of the cornea with incarceration of the iris, whereby the anterior chamber has become partially or completely obliterated. Such anterior staphyloma commonly arises early in life, while the tissues are still plastic. The usual anatomical features of glaucoma are therefore modified, the rise of tension tending to stretch the walls of the globe; yet because the ciliary body is generally affected, the production of lymph may be so much diminished that the tension is not demonstrably increased, although the disk is almost invariably found to be deeply cupped.

Affections of the crystalline lens giving rise to glaucoma. All forms of displacement of the lens, be they spontaneous, traumatic or congenital, may give rise to the development of glaucoma. When a small or shrunken lens is dislocated into the anterior chamber, it may set up little or no reaction, and glaucoma does not occur, but if iritis supervenes the angle may become occluded. If the lens is large, glaucoma rapidly follows, because through the contraction of the sphincter the iris is firmly applied to the posterior surface of the lens, which is thus held firmly against the cornea so that the passage of the aqueous fluid is prevented. When the lens is completely dislocated backwards the intraocular pressure may become increased by reason of the passage of the vitreous fluid into the anterior chamber with the consequent obstruction of the angle, or from the pressure of the vitreous on the root of the iris. When, as by a sudden blow upon the eye, the normal lens is forced to one side and thus brings about the lateral dislocation of the lens, the intraocular tension may suddenly increase because the unequal pressure exerted by the vitreous may block a large part of the filtration angle.

The intumescence of a senile cataract may give rise to the symptoms of glaucoma, and the sudden swelling of the lens after injury or operation not infrequently causes an increase of tension, especially in the aged with stiffened sclera, the onset rapidly following from the pressing of the iris against the cornea. In other cases the filtration area is blocked by the swelling of particles of the broken lens suspended in the

aqueous fluid. It is not at all improbable that some cataracts, both traumatic and congenital in origin, contain substances which are more likely than others to set up irritation and induce the increase of tension. The symptoms subside, however, on the evacuation of the lens fragments.



Glaucoma Secondary to Iritis and the Formation of Annular Posterior Synechia. Fluid accumulating in the posterior chamber has bowed the iris forward into contact with the back of the cornea. (After Collins, in Posey and Wright.)

Intraocular tumors. Intraocular tumors, when they have attained any size, almost invariably give rise to glaucoma if excision of the globe is delayed. In the early stages, the glaucoma being of the acute type, the symptoms resemble the primary form, and the diagnosis may be most difficult, especially where there is haziness of the media.

The filtration angle invariably becomes blocked when tumors involve the iris, and often the canal of Schlemm and the neighboring parts are invaded. Tumors of the choroid may cause the blocking of the angle by the advance of the iris consequent upon the detachment of the retina and pressure upon the vitreous. Glaucoma may come on early while the detachment is comparatively small, especially when the tumor lies near or includes a vortex vein. The deposition of tumor particles and other cells in the region of the filtration area are additional causative factors. Tumors of the ciliary body may not excite to glaucoma until late, but when the anterior chamber is involved, however, obstruction of the angle promptly follows. Retinal tumors act quite the same way as in the case of sarcoma of the choroid. The early symptoms may not be pronounced, but later when the tumor occupies the vitreous chamber the aqueous becomes turbid, the lens and the iris are forced forward to such a degree that the angle becomes blocked.

Intraocular hemorrhage. Intraocular hemorrhage, when it is of considerable amount following upon disturbance in the general circulation, as well as from changes in the ocular vessels themselves, may suddenly raise the tension to the highest degree, and the hardened eye is painful in the extreme. The character of the glaucoma is like that of the inflammatory hemorrhagic type. It is not uncommon that a slight blow upon an old blind eye with degenerated vessels may be followed by copious hemorrhage which undoubtedly was arterial in origin. Hemorrhage into the vitreous from the retinal vessels is probably more frequently venous, and does not necessarily give rise to glaucoma, as the effusion is usually subchoroidal, the choroid and retina becoming detached with the forcing forward of the vitreous. The eye is subjected to direct pressure at the angle with the consequent retention of the fluids.

Detachment of the retina. Aside from that dependent upon the presence of tumor, detachment of the retina occasionally gives rise to glaucoma. It is very rare for a simple detachment to cause it, for the tension in such a case is, as is well known, usually subnormal. Detachment, however, has been found as an accompaniment of iridocyclitis, in which case increased tension is not unlikely to ensue.

Aniridia. Congenital and traumatic aniridia may give rise to glaucoma, although clinically it is difficult to imagine how the angle can be blocked in the congenital cases, yet microscopical examination has disclosed that rudiments of the iris are invariably present, and the cribriform ligament faulty. Part of the angle has usually been found open, but the stump of iris was often adherent to the sclera at the

extreme limit of the anterior chamber for a considerable part of the circumference. In such cases filtration may be maintained for a while until some intercurrent disturbance, like a slight iritis or cyclitis, leads to the obliteration of the angle. In traumatic aniridia the lens is likely to be wounded and the ciliary body displaced, whereby the ciliary processes come in contact with the ligament and obstruction follows.

Secondary to extraction of cataract. Glaucoma sometimes arises, particularly after needle-operations subsequent to flap-extraction, without the presence of, or as the result of, an intercurrent iritis. It has been attributed to the swelling of remnants of the cortex after extraction or discission, during which the character of the aqueous humor has become altered and the spaces of Fontana became blocked by the accumulation of cells; to displacement of the capsule, with traction and irritation of the adherent ciliary processes; and by a down-growth of epithelium into the anterior chamber. After the extraction of senile cataract plastic iritis may develop which binds the iris down to the thickened capsule, fluid accumulates, and the angle becomes blocked. In other cases the iris and capsule may be found incarcerated in the cicatrix. It has been noted to have occurred after extraction, both with and without iridectomy; after extraction preceded by a preliminary iridectomy, and after extraction in the capsule. It is now believed that it usually depends upon the incarceration of the capsule or the iris, or both, in the wound of the incision, and the increase of tension is brought about by either a severe iridocyclitis or by blocking of the filtration angle. After the free discission of capsular membranes, glaucoma may arise from pressure of the fluid following the laceration of the vitreous body, on the root of the iris, or from its obstructing the passage of fluid from the posterior to the anterior chamber.

After iridectomy. Glaucoma sometimes recurs after an iridectomy which has been performed for the relief of glaucoma, and glaucoma may ensue as the result of complications arising out of the actual operation. In such cases where the lens has not been wounded it may be due to various causes which lead to the closure of the filtration angle, the angle may be blocked by a portion of the iris which has been left in the coloboma only to become caught in the scar; exudative processes may unite the lens to the wound with the further entanglement of the iris and ciliary processes. It is a fact observed by all that the danger of the development of glaucoma following iridectomy for purposes other than for the relief of glaucoma is much less than in the actual affection. The eyes of such subjects are usually in a more

healthy condition and the wound is likely to be placed somewhat less peripherally than in the operations for essential glaucoma. When it does occur, however, the same factors as are believed to give rise to glaucoma will be found active.

In the course of iridocyclitis. In certain cases of iridocyclitis there may be so great an accumulation of morbid albuminous fluid in the

Angle of the Anterior Chamber in an Eye which had Glaucoma Secondary to Serous Iridocyclitis. (After Collins, in Posey and Wright.)

anterior chamber that the filtration angle eventually becomes blocked and glaucoma ensues. There may be not much exudation, but the accumulation of fluid displaces the iris and lens backward, and an additional factor is the precipitation in the aqueous and deposits of flocculent granules on Descemet's membrane which further clog the filtration angle. The tension is usually increased thereby, although in some cases it is only transitory, yet if it continues unrelieved the eye becomes blind and the disk is found to be excavated just as in

other forms of glaucoma. In this form the retention is due to the abnormal composition of the fluid and not to the narrowing of the outlet; the filtration angle is distended rather than compressed, and the anterior chamber is deep instead of shallow.

In the higher degrees of cyclitis the secretion process is impaired or suppressed, and the eye becomes soft. The anterior chamber becomes completely abolished through degeneration of the lens and shrinking of the vitreous. Although the filtration angle is annihilated, in such an eye high tension is impossible unless it be accelerated by the rupture of a blood vessel.

Diagnosis. The diagnosis of secondary glaucoma is not difficult when the history of an antecedent inflammation is clear; but it is not at all easy, however, in deep-seated troubles, especially in the early stages of uveal sarcoma. The glaucoma is usually absolute, and it remains confined to that eye which, by being diseased, has caused the increase of tension. Jackson calls attention to the existence of low general arterial tension in a case of secondary glaucoma from intra-ocular tumor, and so impressed was he by this sign that he offers this as a point to bear in mind in the differential diagnosis between primary glaucoma and that secondary to the presence of a tumor.

Hemorrhagic glaucoma. Properly speaking, this disease is a form of secondary glaucoma, but it much resembles the congestive form and is frequently indistinguishable from it. There is often a history of sudden blindness coming on before the attack of the glaucoma. The iris may present the appearance of hemorrhagic infiltration, or there may be blood in the anterior chamber. The chamber itself is never shallowed in the manner so characteristic of other forms of primary glaucoma. It depends upon a grave disturbance of the circulation in the retina; it is, indeed, simply a local manifestation of a general state, yet it is extremely difficult to decide whether the hemorrhagic extravasations have been produced by alteration in the tension of a glaucomatous eye or whether the glaucoma is secondary to the hemorrhages. The glaucoma is a late and indirect result, and the subjects of it have, commonly, high arterial tension, as well as marked viscosity of their blood, two factors affecting the hemorrhages.

Ophthalmoscopically, there are the common appearances of glaucoma together with numerous hemorrhages from the distended and tortuous veins, which are here and there obscured by edema. Such hemorrhages may have occurred as the result of thrombosis and endarteritis, as well as phlebitis, of the retinal vessels, or through degeneration of the vessel walls. At times, especially in the case of venous obstruction, the transudation occasioned by the overfulness of the

vitreous chamber may be so profuse as to obscure the fundus reflex. The cornea then is steamy, the anterior chamber obliterated, the iris discolored and the globe intensely injected and very hard.

The individuals in whom hemorrhagic glaucoma occurs are almost always far advanced in life and subject to the degeneration of their vessels, and they not infrequently die of cerebral apoplexy.

Traumatic glaucoma. Glaucomatous symptoms occasionally arise in an eye that has been contused or otherwise injured, although sometimes the injury may be apparently trifling. The symptoms may be acute and set in in a day or two, or in other cases they may not be present for two or three weeks after the injury, being preceded or not by intraocular hemorrhage, or they are accompanied by a partial or complete dislocation of the lens. Many theories have been advanced to explain the condition, yet none is satisfactory; the cases ought really to be classed as a type of secondary glaucoma. It is relatively rare, and, as might be expected, it is seen more frequently in men than in women. Undoubtedly the injured individual has been susceptibly predisposed to glaucoma, so that the exciting cause, as, for instance, so slight an injury as that occasioned by the lodgment of a foreign body upon the globe, may be all that is sufficient to disturb the nervous control and cause an increase of the intraocular contents, or to change the composition of the aqueous humor. Other cases may follow more serious injuries, as, for instance, contusions like a blow from a fist, without discoverable lesions other than, perhaps, a "black eye," or without presenting changes sufficient to account for the increase of pressure. And, finally, cases in which there are positive injuries to the tissues, as of wounds to the anterior segment, to the choroid, retina or nerve.

Without doubt such happenings disturb the condition of the angle of the anterior chamber, excite to true inflammation and tend to increase of albumin in the aqueous.

Complicated glaucoma. Complicated glaucoma is a clinical type of secondary glaucoma, of which two forms usually have been noted: cataract with glaucoma, and glaucoma occurring in the course of high myopia. Both conditions are fortunately rare. In the case of cataract, only one eye is affected. It is not to be overlooked in any case of maturing cataract, that the lens may swell so much as to press upon the circumlental space and produce glaucoma, and in some cases of high myopia there may arise more or less choroidal disturbance, sufficient, sometimes, to cause glaucoma, in which the visual changes, the excavation of the disk, and the restrictions in the field are of the usual character. The tension is, however, rarely very high, and therefore it

is the excavation of the papilla, and sometimes the unusual amount of pain complained of which lead one to suspect the presence of such a complication. It is not to be expected that the excavation should be so deep as in other forms because, probably, of the general weakness of the posterior segment of the globe, which allows distension of the surrounding parts without exercising such forcible pressure on the lamina cribrosa as has been noted in connection with the other forms of glaucoma.

INFANTILE GLAUCOMA.

"Buphthalmic hydrophthalmia," or buphthalmos (q. v.), is a form of glaucoma, present in childhood, in which the eye is of an unusual size, hence "buphthalmus," that is, ox-eye. It occurs either congenitally, or it develops in the first year of infancy. The nature of the disease has not yet been fully cleared up, but the increase of the intraocular tension is certainly the most important factor in it, leading to the enlargement of the eye, and to blindness through excavation of the optic nerve.

History. The history of this interesting affection remained obscure from antiquity, and the term "buphthalmus" was used by early writers to express several conditions in which there was prominence of the eyeball. It was not until 1722 that Saint Yves first described the true condition; in 1867 Mauthner proclaimed the glaucomatous nature of it, and in 1869 Horner put forward the view that buphthalmia might be due to some congenital abnormality of the angle of the anterior chamber.

Clinically, the globe is much enlarged, usually presented as an elongated oval. The distension of the globe is marked by more or less proptosis, but the most striking feature in buphthalmia is the size of the cornea, which has given rise to the term "megalocornea." The cornea is hemispherical or globular, the radii in both meridians being greatly increased. The sclera, especially near the limbus, is bluish, in consequence of the uveal pigment appearing through it. The anterior chamber is very deep. The iris is usually flat, sometimes infundibuliform, and generally tremulous owing to the lack of support from the lens, but as a rule it shows no signs of inflammation, though it may be atrophic. It may be rent, when the lacerations are to be seen more often at the ciliary attachment. In some cases the membrane is rudimentary or presents a coloboma. The pupil is round, usually slightly dilated, but in rare instances it is either much contracted or widely dilated. In most cases it reacts badly to light, even

when the visual acuity is fairly well maintained, probably because of the atrophic condition of the iris.

The ophthalmoscopic examination in the early stages shows that the media are usually clear, and the retina and choroid normal; the course of the disease progresses more slowly than is the case in the glaucoma of adults, and the retina does not suffer as early. The optic disk is cupped; the appearances of the nerve head are the same as in

The Angle of the Anterior Chamber in a Case of Congenital Glaucoma or primary buphthalmos. (After Collins, in Posey and Wright.)

adult glaucoma, but the variations in size of the vessels are not so marked, and the distinctness of the arterial pulsation is less commonly observed.

While the tension is raised it probably never reaches the level met with in adult glaucoma, owing to the lack of rigidity in the sclerotic in early life.

The subjective signs of diminished retinal sensibility are not want-

ing in the early stages of infantile glaucoma, for the direct sight is usually greatly reduced, although some cases have had remarkably high visual acuity. There is generally contraction of the field of vision, and it is interesting to note that this contraction is analogous in kind with that found in glaucoma of the adult. Although contraction usually manifests itself first in the nasal field, it sometimes assumes a concentric outline. Color-vision, too, may be well preserved, and the condition of the refraction is of interest. Myopia usually exists, but not to so great a degree as might be expected from the length of the globe. Seefelder stated that in his examination of seven eyeballs he did not find present the macular lesions of high myopia. Cases have been cited in which only a low grade existed in one eye, while the other was emmetropic, with quite high visual acuity. Schenck observed that in spite of the large size of the eye the refraction, in his experience, is usually hyperopic or is the seat of compound hyperopic astigmatism. Astigmatism is common, and it is usually with the rule. In the later stages of the affection irregular astigmatism is frequent, owing, of course, to the corneal changes; nevertheless, even with proper correction the visual acuity is generally far below the normal.

The enlargement is caused by an increase of pressure within the eye, and the difference in external appearance between it and the glaucoma of adults is accounted for, in the main, by the physiological properties of the eye in childhood. The extensibility of the sclera in childhood renders it possible for the heightened pressure to effect the enlargement of the eye as a whole, whereas the rigidity of the sclera of the eye of the adult allows of expansion, through increase of pressure, only at the weakest spot—the lamina cribrosa.

Etiology. The originating causes of infantile glaucoma are quite as obscure as are those attending the glaucoma of the adult. It is probable that it is a manifestation of hereditary syphilis. Schmidt-Rimpler, disclaiming a possible connection, admits, however, that hydrophthalmus does develop in the parenchymatous keratitis of congenital syphilis, and further notes that an analysis of Seefelder's cases shows that a large number occurred in families in which numerous cases of fatal disease among children occurred. Zentmayer expresses the thought that the comparative frequency of the disease in the negro might be explained by the greater prevalence of syphilis in that race.

In the histological studies syphilis appears as a true cause from the predilection that disease has for the vascular tissues, from the prominence of the endothelial reactions and the presence of mononu-

clear leucocytic infiltration, yet agents other than the luetic may give rise to similar effects, and the endophlebitis found in certain cases is suggestive of toxic agents in the blood.

Distinct changes are noted in the tissues of the globe. The cornea may be clear or dull, opalescent or bluish; a haze may be the first symptom to appear. The lens is commonly quite clear, but after the nutrition of the eye begins to suffer in the later stages it frequently becomes cataractous. It is of interest to note, in contradistinction to what is the case in adult glaucoma, that the lens in contrast with other parts of the eye is usually smaller than the normal, the mean diameter has commonly been 2 to 3 mm. less, and the antero-posterior diameter also is reduced. The lens appears somewhat spindle-shaped, through the stretching of the suspensory ligament by the expansion of the ciliary ring. This tension of the zonula may lead to rupture and the consequent partial or complete dislocation of the lens. More characteristic is the displacement of the lens either backward into the vitreous or forward into the anterior chamber.

Anatomical changes observed in the cornea. The entire cornea is displaced forward, in consequence of which the peripheral circle becomes stretched and thinned, while the center may be flattened, although it is usually clear and of the normal thickness. Often, however, the base is vascularized and there may be opacities in the cornea. Unique changes take place in the cornea in this disease, and these changes may be the first observable manifestations of the process. So marked are they that some believe that the initial pathologic changes arise in the corneal membrane and that these result in an anterior uveitis which culminates in a secondary glaucoma. The opacities are due to one of three causes: the increased intraocular tension occasions stretching or excites to intercurrent disease; the increase of tension may lead to a diffuse edema so that keratitis bullosa supervenes; forcible stretching not infrequently leads to the rupture of Descemet's membrane with the formation of dark linear opacities resulting from the repair of these injuries. In the most severe cases injury to the distended and proptosed globe may be succeeded by ulceration, with scarring as a consequence, or ulceration may be caused by exposure of the prominent cornea, or from the general malnutrition of the eye.

Changes in the sclera. The sclera may not show any structural alteration, although true hyperplasia and positive thickening have been noted. The thinning is undoubtedly due to the general distension, which distension is most marked in the region of the limbus; true staphylomata are, however, rare.

In the iris. There is nothing characteristic in the changes which have been noted in the iris, although the membrane shows signs of degeneration and atrophy, according to and in proportion to the duration of the disease. In the later stages the ciliary body is usually more or less degenerated and the ciliary muscle atrophic, although the processes may be intact or show only evidence of degeneration, yet at times there may be true inflammation. The choroid, on the contrary, is usually markedly degenerated, the larger vessels of which endure long after the smaller ones have disappeared.

The retina is normal in the early stages, but later on the layer of the rods and cones disappears, and in most cases the nerve fiber layer also atrophies. Hemorrhages from the choroidal and retinal vessels are not uncommon, and when they take place detachment of the retina is usually produced by them. Nevertheless, detachment of the retina from other causes is so common that it may be suspected if a sudden decrease of intraocular tension occurs. The optic disk is invariably found to be cupped, and, in the later stages, extremely atrophic.

Pathogenesis. Buphthalmia is without doubt the infantile form of glaucoma, the cause of which arises in an increased intraocular pressure. Formerly it was believed that buphthalmia depended upon hypersecretion, but in recent years it has been conceded that it is due to the retention of fluid in the eye. It is singular that so striking a condition should give rise to so few evidences of inflammatory processes; but, assuredly, there are none which can be considered to be at all sufficient to maintain hypersecretion. The condition of the angle of the anterior chamber precludes any other hypothesis than that it is caused by defective filtration.

Collins ascribes the origin of the condition to an obstruction to the exit of fluid from the eye, and the occurrence of increased tension, he holds it to be dependent upon an abnormal persistence of the prehuman or prenatal state of the ligamentum pectinatum, which ligament consists of an external laminated zone, with slit-like spaces, and an inner cavernous zone, with large irregular spaces. The space at the angle of the chamber is filled up with a network of fibers, which in the matured eye becomes part of the anterior chamber. The anterior chamber is always deep, the pectinate ligament is larger than ever seen in the healthy eye. Parsons sums up by stating: "Whatever be the exact mechanism, it would seem to be certain that there is a very definite obstruction to the filtration of lymph from the eye at the angle of the anterior chamber, whether this is due to a congenital arrest of development or to intra- or early extra-uterine inflammation must be left an open question. It may be remarked that even

an arrest of development must have some cause, and that this is most probably to be discovered in some intra-uterine inflammatory or toxic condition."

Magitot concludes, after a study of three eyes, two of which were from one child, and from the analysis of 60 published reports, that there are two classes of cases: the one, numerically very few, in which there is little or no inflammatory lesion. In these cases there was found obliterative endophlebitis of the scleral vessels and of the anterior ciliary veins, and in cases where these signs were not pronounced aplasia of the venous system of the angle, together with the absence of Schlemm's canal. The other more numerous classes were characterized by inflammatory lesions more or less variable and intense, extending from affection of the venous system at the angle through the retino-ciliary region and of the choroid, to those in which the entire uveal tract and vorticose veins were affected. Magitot believes that these vascular lesions are the cause of the increased tension, and that it is unnecessary to suppose that an obstruction to the outflow of the aqueous humor exists. And he suggests that posterior glaucoma might readily exist from the obstruction of the vorticose veins, while anterior glaucoma arises from the obstruction of the anterior ciliary veins. Reis, who made a study of seven eyes, found nothing constant. In four the angle of the anterior chamber was open, and in two of these there was an absence of Schlemm's canal. Stimmel and Rotter state the consensus of opinion to be that the disease is caused by an absence, whole or in part, of the canal of Schlemm, which is placed too far back; in the persistence of temporary fetal connective tissue in the angle of the anterior chamber, and in an insufficient separation of the iris from the cornea.

In a recent communication William Zentmayer speaks of his having seen six cases of hydrophthalmus, four of which occurred in colored children, in two of whom there were strong evidences of inherited syphilis. He gives the pathologic findings in two, and his study of them lends additional support to the view that the essential factor in the production of hydrophthalmus is an absence, or an incomplete development, of Schlemm's canal, and that a probable contributing factor is the presence of prenatal connective tissue in the angle of the anterior chamber.

Course. The disease probably always dates from birth, or earlier; yet, owing to its insidious nature, cases rarely come under observation previous to the full establishment of the condition. Some evidence of the disease has been found present at birth in certain cases, or, as in others, it makes its appearance within the first six months of life.

Rosemayer has reported a case associated with plexiform neuroma in which hydrophthalmus developed three years after birth.

The progress of all cases is slow. In some cases it has come to a stop spontaneously, the increase of tension subsiding after a time, although the bigness persisted but did not increase, and the eye retained a moderate amount of sight, dependent upon the condition of the nerve. In other cases it continued to progress until it produced blindness, the enlargement keeping on, sometimes, until quite extraordinary dimensions were attained, and the eye became irritable and painful and ruptured spontaneously, and in the meantime complete blindness had ensued.

Incidence. Buphthalmia is usually bilateral, with no predilection for one side more than the other; the cases the writer of this article can recall have all been unilateral. Sometimes there is nystagmus, and there may be anomalies of structure, as of corectopia, coloboma of iris, posterior lenticonus, plexiform neuroma, etc. A number of cases have presented malformations of the long bones and of the joints.

Heredity. Buphthalmus occurs with somewhat greater frequency in males, and the influence of heredity is well marked; it is essentially a family disease, though direct inheritance is rare. There may be, however, consanguinity of the parents. Carlotti's patient belonged to a family of six persons, four of whom suffered from hydrophthalmus. If buphthalmus is not present in other members of the family they may perhaps show evidences of marked ocular deformities, as, for instance, bilateral aniridia. Perhaps in a given family all the congenital ocular anomalies may have occurred through the effects of some vicious infection or other irritation transmitted through the maternal placenta. Of Zentmayer's six cases, four were negroes.

Ending. In such an article as this, i. e., one prepared for an encyclopedia, it is impossible to detail every contribution to the subject of glaucoma, indeed, such exhaustiveness should neither be desired nor attempted. An effort has been made, however, to present systematically the facts which are already accepted and established, and to indicate the lines upon which investigators are working toward the further elucidation of those facts, as well as to mention others which are pointing to new fields of research. Much of what has here been written was long ago embodied in the discussion of the disease, so that the items as they appear in this article are but the commonplaces in the science of ophthalmology, and no acknowledgment has been made of the original works dealing with the subjects. But whenever the writer has had occasion to note a particular fact of comparatively modern ascertainment, or of especial important knowledge, the

authority has been given. Extensive bibliographical tables may be found in Parson's *Pathology of the Eye*, and in the *Ophthalmic Year Book* may be found the summary of all the important contributions, as well as quite complete title-lists published since 1903.—(B. C.)

NON-OPERATIVE TREATMENT OF GLAUCOMA.

As might have been expected from the fact that glaucoma has been called "gouty eye," the association of so-called gout and rheumatism with (mostly) primary glaucoma is (Richey) not uncommon. When the surgeon suspects or is able to establish the existence of such a dyscrasia, treatment should be given accordingly. This rule should be borne in mind as regards other systemic anomalies—all of which should receive attention where any form of glaucoma is in question. See **General diseases.**

Treatment of acute glaucoma. Although this is almost always operative, yet the Editor is in favor of waiting until the inflammatory storm has passed before resorting to operation. In the interim paracentesis, posterior incision, massage with eserine oil or ointment and, above all, the frequent use of a 5 per cent. solution of dionin will cut short the attack. As a matter of fact he generally uses the above measures in their reverse order, and agrees with the observation of Peter Callan that the lymphogogic effects of dionin should be among the first remedial measures applied in these cases. In addition to local applications a large saline purgative, restriction of diet, plenty of water internally and complete rest should be prescribed.

As A. F. Amadon points out, favorable results follow the general treatment of gouty eye diseases, especially by colchicin alone or by 1-64 of a grain of that alkaloid, given from 4 to 6 times a day, in conjunction with the iodides or salicylates in sufficient quantities to produce moderately free catharsis. The alkaloid, he adds, seems to be far superior to the tincture or wine of colchicum, and he has noticed that the more decidedly the case is of gouty origin the more benefit will be derived from this treatment.

Dianoux prefers sclerotomy followed by miotics and massage. He begins massage twice daily, commencing twelve hours after the operation. The surgeon commences and the patient continues this procedure for the remainder of the latter's life. In addition, a collyrium containing both eserin and pilocarpin, with or without cocaine or adrenalin, according to circumstances, is ordered twice daily. In simple chronic glaucoma Dianoux recommends the following routine examination of patients, "I watch carefully the field of vision for white and colors, the light-sense, the visual acuity, and the accommodation; explain to

the patient the nature of the disease and the results desired and expected from treatment, and teach him to massage his eye twice a day, and at the same time to use the drops. The examination should be repeated every month, and if there is no improvement, or the patient is worse, do a sclerotomy, followed by the treatment already described. Internally small doses of quinine and iodide of soda, alternating with small doses of tincture of strophanthus, may be given with benefit."

Schmidt-Rimpler has so far never had occasion to perform resection of the sympathetic nerve. For alleviating the pain cocaine with pilocarpin is recommended. In some cases of absolute glaucoma, in which all remedies had failed, instillations of scopolamin were useful.

Peter Callan strongly advises the prescription, just referred to (eserin, sulph., gr. i; pilocarpin. mur., gr. ii; sol. dionin. (10 per cent.), fl. ʒii), two drops to be used every hour until the inflammatory symptoms have passed off.

In this connection he says: "I consider this formula of the greatest service in acute and subacute inflammatory glaucoma. It is not always an easy matter to do an iridectomy in an acute case of glaucoma when the inflammation is at its height. By using this mixture the surgeon may postpone the operation as long as it suits him. In fact many cases quickly recover and I fail to see the necessity for any operation. It should be used hourly until the acute symptoms have passed off (which may take 24 to 48 hours) then every two hours. I likewise use it after simple glaucoma operations—beginning, say, 10 days after the iridectomy, using it every night or every other night as the case may be. It has given me excellent results and at the same time has cost me some operations."

Schmidt-Rimpler advises the use of physostigmine as a half per cent. solution from 2 to 6 times daily. As long as central vision does not decline and the visual fields show no diminution in size this local medication [or that by pilocarpin or arecolin (q. v.)] should be continued and no surgical procedure undertaken.

It is not yet clear how this reduction of tension is brought about, the commonly accepted explanation being that during the miosis the stretching of the iris permits of a readier exosmosis of the intraocular fluids.

American patients seem very susceptible to the irritation that follows the use of eserine and it cannot be used in the doses (½ to 1 per cent.) generally prescribed by European writers. This difficulty may be avoided by giving the drug in smaller proportions as an oily solution or in the form of ointment. Another plan is to instil it in conjunction with cocaine or after cocainizing the eye. This procedure not only re-

lieves the pain but increases the miotic action of the drug. Cocain. hydrochlori., gr. j; eserin. salicylatis, gr. ss; aquæ dest., fl. ʒ j.

The eye to be kept closed for 20 minutes after using.

Eserin lamellæ with cocaine also act very nicely.

Schmidt-Rimpler gives the following prescription for the use of the salicylate: Eserin, salicylatis, 0.05; hydrarg. bichlor., 0.002; sodii chlor., 0.01; aquæ dest., 10.0.

A procedure followed by the relief of pain, and even improvement in the glaucomatous condition, is injecting, with an Anel or some other form of lachrymal syringe, the nasal duct of the affected eye with a 25 per cent. solution of antipyrine. This may be repeated two or three times daily, if required; after previous injection with eucapren (q. v.) or some similar mixture.

The non-operative, like the operative, *treatment of chronic glaucoma* is not as satisfactory as in the more acute cases. Indeed the diagnosis from primary progressive atrophy of the optic nerve is not always made with ease and it is quite possible that the treatment may be unconsciously applied to the latter condition rather than to a truly glaucomatous affection. Apart from the questionable employment of iridectomy or one of its substitutes considerable benefit is derived from attention to the general condition. Any lesion or morbific influence whatever, gout, rheumatism, disease of the nose, heart, intestinal tract, kidneys, etc., should be attended to. The most important local treatment is the use of miotics—especially eserin and pilocarpin.

As Posey has pointed out, if these remedies be properly and judiciously applied, if need be while life lasts, the disease may be held in check for an indefinite time and no need arise for the removal of the cervical ganglia, or any other procedure. It is difficult to lay down rules applicable to every case, but the method generally employed by the Editor is to prescribe a ½ to 1 per cent. mixture of eserine in olive oil or petrolatum, one drop, or its equivalent of ointment, to be put into the eye every morning, after which the eye should be kept closed for five minutes. If this is sufficient to keep the pupil well contracted a second dose is not used, during the day, but in any event, another drop is instilled just before retiring. According to the state of the eyes, he employs in his office, once, twice or thrice a week, gentle finger massage and with it a 1 per cent. solution of eserine salicylate. It may be mentioned in this connection that, as Bull points out, both the hydrobromide and the salicylate are to be preferred to the sulphate on account of the greater solubility of the former.

Schleich (abstract in *Die Ophthal. Klinik*, Oct. 5, 1906), reports the result both of operative and miotic treatment of glaucoma simplex,

in cases which had been under observation more than two years. In the cases treated by iridectomy 7.8 per cent. became blind, either immediately or within a short time after operation; 76.5 per cent. showed a more or less gradual progression in the loss of function. while only 15.7 per cent. showed cessation of the process, i. e., no increase in functional disturbance for at least two years.

In a smaller number of cases, forty-six, treated by miotics, the results were: progress of the disease in 61 per cent; retardation in 39 per cent. Schleich believes the prognosis after operative treatment is more unfavorable in the early stage of the disease than later in life. Moreover, the use of miotics after operation makes it difficult to determine the value of the operative procedure. He concludes that iridectomy can not be considered in any sense a trustworthy remedy for glaucoma simplex, because in the majority of cases which are followed long enough it does not give the good results usually ascribed to it, and on the other hand in a larger percentage of cases it produces immediately unfavorable results, at times rapid blindness. He believes further that the value of the faithfully employed miotic treatment has not been as yet sufficiently tested, and the bad results depend partly on a lack of thoroughness in carrying out the treatment.

Some observers have noticed improvement in this form of glaucoma from the use of the ophthalmic oscillator or vibrator in any of its forms. The Victor machine is a valuable device for the purpose, but any instrument that will produce rapid but gentle suction with an alternating release ought to be tried in these cases.

The *treatment of secondary glaucoma* is mostly operative.

It may also be said of secondary glaucoma that the treatment should be directed to the underlying cause.

Very little can be done apart from surgery in *hemorrhagic glaucoma*. The hygienic aspects of the case are important: all causes of worry and excitement should be avoided and the patient's surroundings should be as favorable to complete rest as possible. Salicylate of sodium, quinine and ergot internally are said to be useful. All systemic dyscrasiæ should be promptly treated. In addition to these the indications mentioned under acute inflammatory glaucoma should be carried out, although it must be acknowledged that miotics produce very little effect in this discouraging disease.

The *treatment of buphthalmos* (q. v.) is almost exclusively operative, yet the continued employment of miotics, especially a combination of pilocarpin with cocain and dionin is of considerable value. The Editor has suggested the following combination: Dionin., gr. iv:

pilocarpin. hydrobrom., cocain. hydrobrom., āā gr. i; sodii. chlor., gr. ss; aquæ dest., fl. ʒi.

Three drops of this mixture is put into the eye once a day, and when it begins to lose its effect one or more drops at intervals of two minutes may be instilled or the proportion of dionin increased, to produce a decided edema of the conjunctiva.

NEW AND NON-OPERATIVE METHODS OF TREATING THE VARIOUS FORMS OF GLAUCOMA.

In addition to the foregoing, which may be regarded as the most tried and trusted of the non-operative forms of treatment, others have been, more or less enthusiastically, advanced in recent years. For example, Darier (*La Clinique Ophtal.*, July 10, 1908) maintains that in cases of secondary glaucoma he has seen a single subconjunctival injection of a milligram of iodate of sodium result in rapid clearing of the cornea, diminution of pain and lessening of intraocular tension, but it cannot be relied upon in essential glaucoma, as it may bring out an acute attack.

Stimulated by Sluder's report of a number of cases of obscure headache relieved or cured by placing a 20 per cent. solution of cocaine in the nasal fossa over the region of the spheno-palatine ganglion, Ewing (*Am. Jour. of Ophthalm.*, Dec., 1908) was led to the belief that the same treatment might give relief to the suffering of acute glaucoma, and soon had the opportunity of trying it. An application was made to the region of the nose on the left side, adjacent to Meckel's ganglion, of a 50 per cent. solution of cocain, and the patient's pain in the eye and temple ceased entirely, and the vision rose from 20/19 to 20/15.

Blessig (*Zeitschr. f. Augenheilk.*, Feb., 1908, p. 177) regards the iodin preparations as being very useful in the treatment of glaucoma, especially of the hemorrhagic form.

Moffat (*Homeo. Eye, Ear and Throat Journ.*, July, 1908) writes concerning the value of homeopathic remedies in the treatment of glaucoma and the application of the principle of *similia similibus curantur* to the therapeutics of this affection. He gives a list of the principal remedies which are indicated in the treatment of glaucoma, and includes among them aconite, bryonia, conium, gelsemium, potassium iodid, osmium, physostygmin, rhododendron, etc. In the discussion of his paper Norton stated that he had used gelsemium, phosphorus, iodid of potassium, bryonia and spigelia with benefit. Linnell, while a firm believer in the efficiency of homeopathic remedies in this

disease, would not rely upon them alone. His best results were from bryonia, gelsemium and osmium.

Gilbert (Graefe's *Archiv f. Ophthal.*, Vol. LXXX, Part 2, 1912) concludes from extended clinical observations that: 1. Periodic venesection regulation of blood and intraocular pressure is of value in the prodromal stage of the disease, not to the exclusion of miotics, however, and treatment of the general condition according to Eversbusch's rules. 2. In evolved glaucoma, venesection should be the first therapeutic measure, preceding a prospective operation for glaucoma simplex by six to twenty-four hours, for inflammatory glaucoma by twenty-four to forty-eight hours.

On seventy-three eyes of forty-one patients, Knapp (*Klin. Monatsbl. f. Augenheilk.*, June, p. 691, 1912) used the "pressure massage" of Domec, which consists of applying the thumb to the cornea through the closed lid, and making repeated pressure at a rate of about 100 to the minute. Tonometer readings were taken before and after, and at frequent intervals during treatment. In a few minutes massage of normal eyes produced a pronounced fall of tension, the average being 8.91 mm. after 1,000 pressures. The fall obtained in simple glaucoma always disappeared within fifteen minutes, and in acute glaucoma a result was seldom obtained. Greater and more lasting effects were obtained after operations in which a filtering cicatrix had been aimed at (iridectomy and sclerectomy), and massage is recommended as an after-treatment in such cases.

On the basis of Fischer's interpretation of glaucoma as due to an increase in the normal affinity of the ocular colloids for water, Thomas (*Jour. of Oph. and Oto-Laryngology*, Vol. V, p. 205, 1912) used subconjunctival injections of sodium citrate to reduce tension. The employment of this salt was suggested by the antagonism existing between acids and neutral salts as regards the imbibition of water by colloids. After instillation of cocain and adrenalin solution into the conjunctival sac, from 5 to 15 drops of a 4.05 per cent. to 5.41 per cent. solution of chemically pure crystallized sodium citrate are injected. To the above writer's nine successful cases of primary and two of secondary glaucoma, Sedwick (*Ophthalmic Record*, Vol. 20, p. 328, 1912) adds one of acute glaucoma in which on four occasions pain was controlled, and tension fell in a few hours. But the pain immediately following the injection was severe. Grandclément (*Clinique Ophtal.*, Vol. 18, p. 275, 1912) reports the success of the method in a case of glaucoma, secondary to scleritis and in which a number of other measures had failed. Happe (*Archives d'Ophtal.*, Vol. 32, p. 457, 1912), in an experimental study covering eight normal and nine glaucomatous eyes, not only

failed to confirm Fischer's experience, but saw a distinct rise of tension in several instances. Where lowering of tension was obtained, moreover, it was decidedly inferior to that produced by eserin.

A special method for combined use of pilocarpin and dionin in glaucoma is recommended by Von Arlt (*Archives d'Ophtal.*, Vol. 32, p. 457, 1912). During introduction of the drugs compression of the lachrymal canaliculi must be maintained. One-thirtieth grain of powdered pilocarpin is introduced, and eight minutes later 1/12 grain of powdered dionin. The process is repeated every three or four days, and in the meantime a 2 per cent. or 3 per cent. solution of pilocarpin is instilled every three hours. The use of the dionin is timed so that the maximum effect of both drugs may coincide.

Dutoit's experiments (*Zeitschr. f. Augenheilk.*, Vol. 28, p. 131, 1912) as to the value of prolonged administration of potassium iodid in cases of arteriosclerosis with or without glaucoma were in part favorable, but generally inconclusive. Risley's report (*Annals of Ophthal.*, Vol. XX, p. 663, 1912) of prompt relief of glaucoma pain by the high frequency current was duplicated in discussion by other workers. The recommendation by Weekers (*Clinique Ophtal.*, Vol. 18, p. 282, 1912) of the internal administration of chlorid of calcium is poorly supported. It is founded on a demonstration by earlier workers that the calcium salts inhibit the processes of transudation and exudation elsewhere in the body.

Still more recently a number of investigators have reported upon the non-operative treatment of glaucoma. Short abstracts of these papers may be found in the *Ophthalmic Year-Book.*

Lawson (*Trans. Oph. Soc. U. K.*, Vol. 33, p. 194, 1913) gives the history of a case of bilateral glaucoma kept in check for thirteen years without surgical intervention; he does not agree with the attitude of those surgeons who insist on an operation so soon as it is certain that the intra-ocular tension is habitually raised, and prefers to try the effect of palliative treatment, provided that the case can be secured early enough. He thinks that too much reliance has been placed on the use of miotics, and too little on the general management of the patient. Eserin should be used in the smallest doses that suffice to control the rise in tension; fresh solutions must always be employed; instillations at night-time are an important factor in obtaining success.

Fischer (*Annals of Ophthalmology*, Vol. 22, p. 359, 1913) is in favor of rectal injections of alkaline hypertonic sodium chlorid solution, combined with a subconjunctival injection of sodium citrate solution.

Piccaluga (*Annali di Ottalm.*, Vol. 42, p. 335, 1913) tested the post-operative effect of massage in two series of cases, one consisting of

patients on whom the Lagrange sclerectomy for glaucoma had been done, and the other of patients on whose eyes iridectomy had been performed, either as a treatment for glaucoma or as preliminary to cataract extraction. In the eighteen patients who had been subjected to either simple or combined sclerectomy, the effect of massage was always a considerable diminution of the tension, which in some cases continued for two days only, and in others for more prolonged periods. Of the sixteen cases of simple iridectomy, seven showed an increase of tension or an absence of change following massage, while in the remainder there was a reduction of from 2 to 13 mm. of Hg. Furthermore, the average duration of the reduction after massage in the second series was much less than that in the first series. In three cases in which sclerectomy was done on one eye and iridectomy on the other, a marked diminution of tension was produced by massage in the sclerectomized eye, and none, or in one case an increase of tension, in the iridectomized eye. In another instance a greater reduction was had in the sclerectomized than in the iridectomized eye, and in only one case was an almost equal reduction obtained in either eye of a patient on whom the two respective operations had been performed.

Calendoli (*Annali di Ottalm.*, Vol. 41, p. 775, 1913) studied thirty cases with the ophthalmometer and with the Schiötz tonometer, none of the patients having had an operation on the eyeball. From the use of 1 per cent. solutions of eserin and pilocarpin in nine cases of glaucoma, the action of both drugs is stated to be more marked the higher the tension, at any rate within certain limits. There may be a slight and transitory rise of tension during the first few hours after use of the drugs, the reduction being always more marked after such an interval. When pilocarpin is combined with paracentesis, the reduction of tension is greater. The action of eserin is stated to be less constant than that of pilocarpin. Hertel (*Jour. Am. Med. Assoc'n.* Vol. 61, p. 231, 1913) has succeeded in causing a marked reduction in the intra-ocular pressure in animals by varying the food and by intravenous injection of various substances which modified the molecular concentration of the blood. This remarkable change in the intra-ocular pressure is independent of the general blood-pressure, and it can be due only to changes in the processes of osmosis. The research was undertaken to seek an explanation for the remarkable drop in intra-ocular pressure in the course of diabetic coma to which Krause and Heine called attention and suggested its differential importance in coma of different origins. Ricca (*Archivio di Ottalmologia*, Vol. 20, p. 469, 1913) investigated the action of ipotenina, a liquid composed of iodid of sodium, nitrate and nitrite of sodium, bicarbonate of

sodium, citral, and lobelin. Tonometric measurements of rabbits' eyes, before and after using the preparation, showed instillation produced a diminution of intra-ocular tension, of 3 or 4 mm. of mercury. Hypodermic injections reduced the tension 6 to 8 mm. The action was prolonged for several days after instillation. Repeated daily injections and large dosage never gave rise to any disturbance or any sign of intolerance. Tristaino (*Archivio di Ottalmologia,* Vol. 20, 1913) made tonometric measurements on rabbits and on clinical cases of glaucoma. In the rabbit subconjunctival injections of a 10 per cent. solution of chlorid of calcium were made. To four patients, two or three teaspoonfuls of a 6 per cent. solution in water and syrup were given three times daily. In the rabbits subconjunctival injections lowered the ocular tension from 4 to 8 mm. of Hg., according to the frequency and strength of the dose. In the glaucoma cases a marked lowering of tension was obtained, the total reduction varying from 20 to 45 mm. of Hg. Marked relief from pain also resulted, together with rapid absorption of hyphema in a case of hemorrhage.

W. C. Posey (*Jour. Am. Med. Assoc'n,* July 18, 1914) has supplemented his earlier reports (*vide infra*) by 65 cases of glaucoma treated by non-operative measures with a further account of 18 cases now reported for the first time. One was observed for a period of 18 years, 2 of 10 years, 1 of 8 years, 1 of 7 years, 7 of 6 years, 1 of 5 years, 2 of 3 years, 2 of 2 years and 1 of 1 year.

These 18 cases presented but 24 eyes for analysis, some of the patients having already lost one from glaucoma before consultation, while in others but one eye was affected. Of these 24 eyes, 13 showed but the rudiments of the disease at the first examination, the glaucomatous process was moderately advanced in 8, while in 3 central vision and the visual field were greatly compromised. In the first group practically normal vision has been maintained while the cases have been under observation, for periods ranging from 5 to 18 years, an average of 7½ years. In the second group of 8 eyes, vision has been maintained for periods ranging from 2 to 10 years, an average of about 4 years, while in the 3 eyes which were in the most advanced stage of the disease, vision has been maintained for periods ranging from 1 to 6 years, an average of 3 years. It should be noted that in 2 out of these 3 eyes the disease was of a pronounced hemorrhagic type and that notwithstanding this, vision is still maintained in 1 after a period of 6 years and that blindness ensued in the other after the maintenance of 6 years of fair vision.

In view of such favorable statistics from the use of miotics, when the risks and complications attending all operations on the eye are

considered, as well as the possibility of error in the diagnosis and operation being performed on eyes with merely atrophic nerves, is operation ever justified when both central and peripheral vision are normal, without trial of what miotics can do?

"In 11 eyes in which the disease was noted as being moderately advanced, in the first group, 2 maintained vision for 8 and 10 years, respectively, and 1 went blind in 2 years, in the second group vision has been maintained for periods ranging from 2 to 10 years, an average of about 4 years. The best results of all, relatively speaking, were attained in the far-advanced or desperate cases, for of the 5 cases so designated, vision and field were maintained without further loss in 1 case for 10 years, and in a second with but slight loss during the same period. In the remaining 3 eyes, vision has been maintained for periods ranging from 1 to 6 years, and this in spite of the fact that in 2 of the latter the disease had assumed a hemorrhagic type.

"It is in this class of cases that iridectomy has been attended with such bad results, and while cyclodialysis and the trephining operations may be less injurious, I shall continue to employ miotics continuously and energetically until convinced by the report of a series of suitable cases that operative measures have proved their superiority. My observations have convinced me that miotics cannot be regarded in any sense as curative, for notwithstanding their continuous use, the glaucomatous process still goes on, very slowly, it is true, but the eye grows steadily harder, the excavation becomes broader and deeper and the anterior chamber shallower. Again, I desire to emphasize what I have already said elsewhere, namely, that miotics should be relied on as the sole means of treatment only in those cases which are free from attacks of so-called glaucomatous congestion, the presence of such congestive symptoms being in my opinion the chief indication for some form of operative treatment, be it iridectomy, cyclodialysis or trephining; and second, that to gain the full benefit of miotics it is necessary that they should be administered properly. Beginning in doses small enough to avoid creating spasm of the ciliary muscle, and rapidly increasing the dose until the pupil of the affected eye is strongly contracted, this degree of contraction should be maintained as long as life lasts by gradually increasing the strength of the solution, from time to time, and by instillations of the drug at intervals of every three or four hours.

"The miotics which are best adapted to control intraocular tension are physostigmin (eserin) salicylate and pilocarpin nitrate. This salt of physostigmin is more persistent in its effects and less changeable in solution than other salts of the drug and is less irritating to the con-

junctiva. I prescribe a solution of pilocarpin to be used about every four hours, morning, noon and evening, and one of physostigmin of twice the strength at bedtime, thereby avoiding in a measure the blurring of vision which is occasioned by the action of the physostigmin on the ciliary muscle during the day, while the eye receives the greatest effect of the drug during the eight hours or more which elapse between the instillations of the drops during the night. In incipient cases of the disease an excellent initial dose is that of $\frac{1}{5}$ grain of pilocarpin to the ounce of water. The strength should be gradually increased, so that at the end of a year 1 grain to the ounce is employed, at the end of the second year 2 grains, and at the end of third year 3 grains to the ounce solution. This strength will suffice to maintain the pupils at the desired point of almost pin-point contraction. Physostigmin should be employed in half the strength of pilocarpin and should be increased in solutions of equal proportions.

"Conjunctival irritation can usually be avoided by employing only fresh and sterile solutions of the miotics and by frequent cleansing of the conjunctiva by boric acid solution. Should such irritation arise, local applications of argyrol and flushing of the conjunctiva with mild lotions, conjoined with the use of ice compresses and a weakened dose of the miotic will usually occasion its prompt disappearance.

"Gentle massage of the eyeball is of decided advantage and should be practised several times each day, for five minutes at a time. In addition to these local measures, the patient should be instructed as to the number of hours daily the eyes should be used in near vision. All near work should, of course, be restricted, and should be carried on only under the most favorable conditions regarding illumination, posture of the patient, etc.

"Proper lenses should be adjusted to the eyes for both near and far use, and the refraction should be frequently estimated and any error corrected, changes in the refraction being rendered frequent by the action of the miotic on the ciliary muscle.

"A large number of hours daily should be spent in the open air, and, as the disease is frequently the ocular expression of chronic rheumatism and gout, the patient should be urged to spend the greater part of the year under the most favorable climatic conditions to combat that diathesis. The skin should be kept active, the gastro-intestinal apparatus regulated, and any local source of inflammation or irritation, neighboring on the eyes, such as inflammation in the nasal passages or their accessory sinuses, should be allayed. Particular care should be given to the peripheral circulation, nitroglycerin and strophanthus being often of value. Strychnin should be administered, not only on

account of its action on the circulation, but also because of its influence on the optic nerve. On account of their antirheumatic properties, the salicylates are of decided value and should be administered frequently for continued periods.'' See, also, Posey's remarks on *iridectomy versus miotics,* under operative treatment of glaucoma.

OPERATIVE TREATMENT OF GLAUCOMA.

When general treatment and local applications have failed to relieve the glaucomatous symptoms or to arrest the progress of the disease, or when the surgeon is satisfied that simple measures will be useless, immediate operative proceedings should be advised.

Operations for the cure of glaucoma may be divided into three groups: Those on the anterior half of the eye; those on the posterior half; and those on the sympathetic system of nerves.

Paracentesis of the cornea. Efforts to decrease the hardness of the eyeball by permitting some of the contents to escape after a simple puncture of its envelope have been made for a century or more. Guérin, of Lyons, according to de Wecker, having employed both corneal and scleral puncture for this purpose as early as 1769. In recent years, however, since it has become apparent that the effect of the procedure is but transient, it has been entirely superseded by other and more complicated operations, and only resorted to when a rapid and evanescent lowering of the tension is desired. The puncture, which lowers the tension by permitting of the escape of aqueous consequent upon the opening of the anterior chamber, is designated as paracentesis of the cornea, and is made as follows: After thorough cocainization of the eye, or, if the eye be very irritable and painful, after etherization or general anesthetization by a more rapidly acting and evanescent general anesthetic, a speculum is introduced, the globe steadied with fixation forceps, and the cornea incised in its horizontal plane 1 or 2 mm. from the limbus, by a small keratome. A Desmarres paracentesis needle, which consists of a small lance with an abrupt thickening of the base to prevent the needle from entering too deeply into the anterior chamber, was formerly employed, but either this instrument or a von Graefe cataract knife suffices. The aqueous should always be permitted to run off slowly, this being accomplished by gently pressing the posterior flap of the wound, until the greater part of the fluid has escaped, and by the slow withdrawal of the knife.

After the usual toilet of the eye and the instillation of eserin (gr. i to f. ʒi), a bandage is applied. Ordinarily the wound will close in from 12 to 24 hours. It may then be re-opened by a Daviel spoon

if the tension has again risen, indeed the paracentesis may be repeated a number of times if the necessity arise.

Indications. In acute glaucoma to temporarily lower tension for the purpose of deepening the chamber and lessening the congestion of the eye before the performance of iridectomy. In secondary glaucoma to relieve blocking of the filtration angle from lens matter or inflammatory exudate or blood.

OPERATIONS WHICH AIM TO EFFECT A COMMUNICATION BETWEEN THE ANTERIOR CHAMBER AND THE SUBCONJUNCTIVAL SPACES.

Anterior sclerotomy. Considering that the relief of tension following iridectomy resulted more from the incision of the sclera and the opening of the spaces of Fontana than from the excision of a piece of the iris, de Wecker (*Traité des Maladies des Yeux*, 1867) in 1867 introduced an operation which he termed anterior sclerotomy, whereby he aimed to establish a cicatrix in the angle of the anterior chamber through which the intraocular fluids could filter out of the eye. In the following year, Stellwag von Carion practised this operation on the living subject, and two years later, in 1871, Quaglino reported five cases of glaucoma which he had successfully treated by sclerotomy. During this year de Wecker modified his original operation somewhat to avoid the prolapse of the iris which had attended some of his earlier incisions. This modification of the operation, which has been widely practised by others, is performed as follows: After the pupil has been contracted ad maximum with a miotic, and the eye cocainized, the lids are separated with the speculum, and the globe steadied by grasping the bulbar conjunctiva a few mm. distant from and below the lower limbus of the cornea. A narrow von Graefe cataract knife is introduced 1 mm. from the outer corneal limbus, as represented at *a* in the figure and made to emerge at *b*, at the other side of the anterior chamber. The incision is then continued upwards with slow sawing movements, the cutting edge of the knife being directed somewhat anteriorly, until only a bridge of tissue, about 2 mm. broad remains at *c*, this being left undivided to prevent iris prolapse. After the aqueous has been permitted to escape from the eye by cautiously tilting the edge of the knife slightly forward, the knife is slowly withdrawn. If the pupil is round, eserin is instilled and a bandage applied, but if it be oval or irregular, indicating a tendency of the iris to prolapse, the membrane should be gently stroked by a spatula and attempt made to restore the pupil to its normal form. In the rare cases that actual prolapse of the iris occurs, the prolapsed portion should be excised at once, and the sclerotomy converted into an iridectomy. Wiegman (*Kl.*

Monatsbl. f. Augenheilk, 1897, p. 277) recommends making the incision with a double keratome which he designed for the purpose.

Complications of anterior sclerotomy. In addition to prolapse of the iris which has just been referred to, when the chamber is very shallow, the operator may fail to enter the anterior chamber, the knife being inserted instead into the deeper layers of the cornea. To avoid this accident and also its converse of making the incision too far posteriorly and thereby wounding the lens, the best of illumination is necessary and the operator will do well to resort to the condensation of artificial light. In case the operator gives a wrong direction to his knife and splits the cornea or makes what is known as the interlamellar incision, the knife may be withdrawn and re-entered at a better angle. Should, however, the chamber have been opened and aqueous permitted to escape, the knife should be withdrawn and the operation postponed until the chamber has reformed. The same delay is advised if the operator realizes in time to desist, that the counterpuncture has been made too posteriorly. (See p. 509 of this *Encyclopedia.*)

After the toilet of the eye and the instillation of a miotic, a bandage is applied, the dressing being removed at the end of 24 hours. The lips of the wound may be found coaptated, and healing may be perfected so that the thin cicatrix is barely visible. Oftener perhaps there is a gaping of the wound and the condition described by de Wecker as a filtration-cicatrix forms. This is less pronounced than the cystoid cicatrix which is observed after the prolonged and imperfect healing of incisions and wounds of the eyeball, and consists of a broadening and elevation of the scar with a slight bulging of the conjunctiva. De Wecker claims that such a cicatrix affords the maximum amount of drainage for the intraocular fluids, though he also asserts that a considerable degree of leakage may be attained through even a closely united scar.

Indications. According to de Wecker, anterior sclerotomy is particularly indicated prior to iridectomy when the tension is very high and the anterior chamber shallow. In chronic glaucoma in combination with miotics, he considered it to be the operation of choice. He also recommends it in hydrophthalmus, in hemorrhagic glaucoma and in cases of absolute glaucoma to lessen pain. Finally, he commends its performance in the prodromal period of inflammatory glaucoma when miotics are without effect.

After operating on a large number of cases, Panas (*Maladies des Yeux*, p. 521) concluded that anterior sclerotomy occupies the middle place between a large peripheral iridectomy and repeated paracentesis

of the cornea. In chronic glaucoma, he found that it was a useful supplement to miotics. In hydrophthalmus, however, it was as valueless as all forms of operation, and in his opinion did not remove the necessity of enucleation in absolute glaucoma. Although at one time extensively practised, especially by French surgeons, sclerotomy has now but few advocates, as iridectomy with a scleral section has been shown to possess all the advantages of sclerotomy, while affording at the same time a possibility of re-establishing a communication between the anterior chamber and the canal of Schlemm.

Modifications of the operation. Quaglino's (*Ann. di Ottal.*, 1871, I, p. 200) incision was much the same as is usually employed for iridectomy and was made with a large triangular keratome, the knife being entered 2 mm. behind the limbus. During the withdrawal of the keratome, the handle was tilted back to raise the blade, and prolapse of the iris guarded against by permitting the aqueous to flow slowly off. Despite this precaution, however, and the use of eserin, prolapses were frequent, necessitating excision of the prolapsed portion of the iris.

Snellen (*Bericht der International Ophthalm. Kongress*, Heidelberg, 1888, p. 244) adopted Quaglino's method, as he found it less liable to induce prolapse of the iris. He treated a series of cases of bilateral glaucoma by iridectomy on one eye and sclerotomy on the other and found that better vision was obtained by the latter. He, therefore, recommended sclerotomy, repeated if necessary as the initial operation, resorting to iridectomy only when the sclerotomy failed to prevent a rise of tension.

Bader (*Royal Lond. Hosp. Reports*, Vol. VIII, p. 430) followed de Wecker's method in its essential details, but aimed at making the corneal puncture and counter-puncture as near as possible to, and in front of, the insertion of the iris. He endeavored to leave a large bridge of conjunctiva, stretching across the sclerotic incision, and, with this in view, divided an extent of sclerotic equal to nearly a third of the circumference of the cornea.

Martin (*Annal. d'Ocul.*, Vol. XXXI, 1880, p. 236) precedes sclerotomy by paracentesis with a Desmarres needle introduced into the cornea at the vertical meridian 1 mm. from the limbus. If aqueous still remains after withdrawal of the needle, he permits it to drain off by the aid of a lance. The wound is then enlarged with one or two cuts of the iris scissors.

Both Panas (*Soc. Franç d'Ophtalm.*, 1883) and de Wecker (*Annal. d'Oculistique*, 1885, p. 10) advocated the operation of cicatrisotomie, or outétomie, when rise of tension persists after iridectomy. This

consists in incising the cicatrix with a narrow Graefe knife, in order to divide the attachments of the iris in the angle of the cicatrix, the conjunctival bridge being left undisturbed. The writer has found this procedure of value in the several cases in which he has resorted to it.

In cases of glaucoma simplex of a suspected malignant type, Pflüger (*Bericht der Ophthalm. Gelsel*, 1882, Vol. 16, p. 152) incises the cornea as if for a broad iridectomy, but withdraws the linear knife with which the incision is made before the section is completed. If no decrease in tension occurs after the escape of aqueous, he considers the operation completed. Should, however, the tension fall, the incision is finished and the iris excised.

Irido-sclerotomy. As a satisfactory substitute for iridectomy, and without disadvantages of prolapse of the iris and the formation of a cystoid cicatrix, Panas (*Arch. d'Ophtalm.*, Vol. IV, 1884, p. 481) devised this operation, which consists essentially of combining a de Wecker's sclerotomy with iridotomy for the relief of high tension in eyes with extremely shallow or obliterated anterior chambers, such as occurs in pupillary occlusion when the posterior chamber is enlarged as a consequence of over-accumulation of aqueous. The incision is made with a Graefe knife below and to the outer side, equidistant from the horizontal meridian and the lower limbus. As soon as the point of the knife enters the anterior chamber, it is plunged through the iris 8 to 10 mm. back of this membrane and then made to perforate the iris a second time at the counter-puncture, which is situated at a point corresponding to the incision. The limbal tissues are next incised, as in an ordinary sclerotomy, to an extent of 2 to 3 mm. Finally, the cutting edge of the knife is turned somewhat anteriorly and as the instrument is slowly withdrawn, the remaining bridge of iris tissue is completely divided, a retraction of the central portion of the iris indicating that this has been accomplished.

Indications. Panas claimed that this operation was applicable to cases in which the increased tension was dependent upon an excessive accumulation of the aqueous humor, especially when the anterior chamber was very shallow. It entailed but little risk of injury to the lens. He thought it particularly adapted to all cases of adherence of the iris with abolition of the anterior chamber, as, for example, in corneal staphyloma. It may also be performed as a preliminary to iridectomy.

Scleriritomy. A quite similar operation has also been described by Knies. The steps of his method are as follows: After the pupil has been well contracted with eserin, a very peripheral incision is made, preferably above, either with a von Graefe or a Beer's knife. The incision

engages the iris and a sort of irido-dialysis results from the division of the root of the iris from the sclera.

De Wecker regarded this operation with disfavor on account of the very evident danger of injury to the lens. A somewhat similar procedure to irido-sclerotomy was also introduced by Nicati (*Rev. générale d'Ophtalm.*, 1894, p. 8, ref. *Jahresber. f. Ophtalm.*, 1894, p. 401) in 1894. This operation, which was termed scleriritomy, was particularly advocated in staphylomata, though found by its inventor to be of service in ordinary glaucoma.

The essential difference in the incision planned by Nicati is that the iris is incised from before backwards instead of from behind forwards, as in the Knies (*Bericht der Ophthalm. Gessel*, 1893, p. 118) and Panas procedures. The incision is made precisely as in an ordinary sclerotomy, but in withdrawing the knife, it is given a rapid quarter turn, so that its plane is brought at a right angle to that of the iris with the edge backward. After the aqueous has escaped, the knife is rapidly withdrawn, incising the root of the iris. The lips of the wound are now made to gape so that the blood may be permitted to escape from the anterior chamber.

Combined sclerotomy of de Wecker. In 1894 de Wecker (*Annal. d'Ocul.*, 1894, C. XII, p. 261) introduced another operation, which has for its object the production of artificial dialysis. After the pupil has been contracted with eserin and the eye cocainized, de Wecker introduced the 6 mm. broad, stop-knife which he especially designed for the purpose, 1 mm. behind the upper limbus, and the incision was made as for ordinary iridectomy. After the aqueous has flowed off slowly to prevent iris prolapse, a very delicate iris forceps with prongs well rounded off at the extremity are introduced into the anterior chamber and a fold of iris seized 2 mm. from the limbus. The iris is then gently drawn toward the center of the cornea and traction made until its periphery is detached from its root to the extent of 6 or 8 mm. A profuse hemorrhage usually follows, filling the anterior chamber. The forceps are then opened to prevent the iris being drawn back again to the periphery and held for a few minutes in the incision to facilitate the escape of blood and prevent the severed iris from prolapsing.

Incision of the iris angle. This operation, devised by de Vincentiis (*Annali di Oltalm.*, 1893, XXII, p. 540) in 1895 and termed by him incisione dell' angolo irideo, aims, as its name indicates, in the incision of the tissues within the iris angle. For this purpose de Vincentiis employed an instrument with a needle-like shaft, at the extremity of which is attached a small, sickle-shaped, curved blade with the cutting

surface on the convex side, the shaft being devised to completely close the incision made by the cutting portion so as to prevent the escape of aqueous. After eserinization and cocainization, the puncture is made obliquely through the sclera 1.5 mm. from the limbus on a level with the horizontal diameter of the cornea and made to enter the anterior chamber. (When operating on the left eye, the entrance puncture is made down and out; on the right eye, the operator standing behind the patient's head and operating with the right hand, up and out.) The point of the knife is then passed across the chamber and, by giving the handle a slight rotary motion, incisions are made of 1 or more mm. in depth into the tissues of the anterior chamber. As the instrument is withdrawn, the convex cutting edge is made to sweep around the periphery of the chamber, incising the angle from the point of first incision almost to the entrance puncture. Eserin should be instilled for some days after the operation.

Tailor (*Annali di Ottalm.*, 1891, XX, p. 117), de Vincentiis' assistant, gives the following indications for this procedure—prodromal, acute and chronic irritative glaucoma; hemorrhagic glaucoma; chronic glaucoma simplex; secondary glaucoma in so-called iritis serosa (cyclitis) and anterior sclerotico-choroiditis.

Czermak (*Augenärtzliche Operationen*, Vol. II, p. 234), however, thinks that an exact performance of this operation would only be possible in eyes with free anterior chambers, in which high tension is not the result of attachments of the iris root, but due to other causes, as, for instance, a blocking of the meshes of the pectinate ligament. Where the iris root is adherent, he claims the operation could easily result in extensive irido-dialysis.

From an anatomical examination made on 16 dead infants' eyes, upon which they had performed the de Vincentiis operation and de Wecker's sclerotomy, Valude and Duclos (*Ann. d'Ocul.*, 1898, XIX, p. 98 and 241) conclude that the same result is obtained from either operation and that either may be termed an incision of the iris angle. Clinical experience proved the procedure of value in their hands in prodromal and in some cases of chronic glaucoma, and they deemed it worthy of trial in hydrophthalmus.

OPERATIONS WHICH AIM TO EFFECT A COMMUNICATION BETWEEN THE ANTERIOR CHAMBER AND VITREOUS.

Sclero-cyclo-iridic puncture. Chibret (*XII Intern. Congress, Sect. XI, Ophthal.*, 1898, p. 29) effected a communication between the posterior and anterior chambers by making a flat puncture by means of a double-edged knife 3 to 4 mm. from the limbus, through the sclera

into the angle of the anterior chamber. The knife is guided towards the anterior surface of the iris, the thickest portion of which is speared and the iris pulled towards the pupillary center, thereby loosening the attachment of the iris root to the posterior corneal surface; stronger tugging sometimes causes iridodialysis. This procedure is repeated in 5 to 6 meridians. Severe hemorrhage into the anterior chamber usually follows. Tension is markedly decreased in from 20 to 40 hours, and vision continues to improve for 8 days after the operation. The operation is repeated if the first procedure is unsuccessful; in very rare cases is a third operation necessary.

The Sterns-Sommercole sclerotomia antero-posterior. This operation is done after an ineffectual iridectomy, and consists in the introduction of a Graefe knife (2 mm. within the limbus) into the anterior chamber in the region of the coloboma. The knife is then passed posteriorly into the vitreous. The procedure resembles Antonelli's (*Révue générale d'Ophtalm.*, 1896, p. 385) peripheral iritomy (iritomie periphérique), and should perhaps only be attempted in blind eyes, because of the liability of producing a traumatic cataract. Antonelli employed a double-edged lance, which he introduced in the sclero-corneal region nearly perpendicular to the surface of the globe.

The point of the knife is thrust into the chamber, into the tissue of the iris, and its base incised by sweeping the knife around the periphery of the chamber to the extent of 5 to 6 mm.

A similar section of the iris root by means of a lance knife introduced perpendicularly into the vitreous through the cornea, scleral limbus, sclera and iris-zonula was attempted by Schnabel (1868-9) in a small number of eyes with absolute glaucoma, as well as in glaucoma after perforating serpent ulcer, but because of the uncertainty of results he soon abandoned the operation.

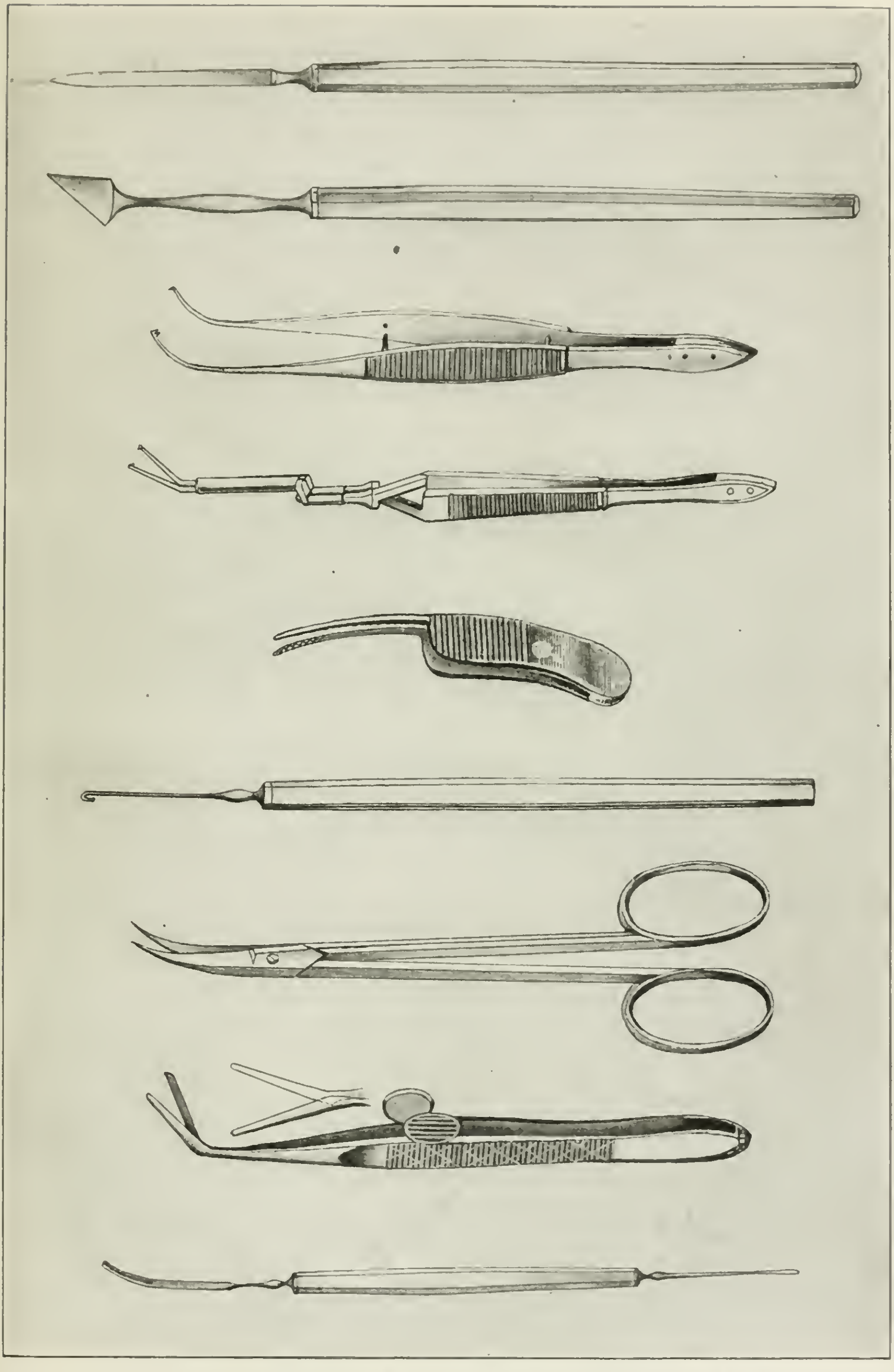
Hern's operation. Hern (*IX Internat. Congress of Ophthalmology*, Utrecht, Aug., 1899) aimed at re-establishing the connection between the anterior chamber and the vitreous by means of what he termed a corneo-irido-vitreous puncture. This was accomplished as follows: After iridectomy, he introduced a double-edged Graefe cataract knife, about one-third to one-quarter the size of the ordinary instrument, through the cornea about a line interval to the sclero-corneal junction, through the coloboma, into the circumlental space. Care should be exercised that the needle enters the cornea with its long diameter parallel to the antero-posterior axis of the globe, and with its cutting edge lateral, so that when the vitreous chamber has been entered a lateral movement of the handle increases the extent to

which the filtration angle is opened up and the connection between the chambers established.

Iridectomy. In 1856 Albrecht von Graefe (*Archiv f. Ophthalm.*, III, 2, 1857, p. 456) discovered that iridectomy is capable of curing glaucoma. This must undoubtedly be regarded as the greatest contribution which has been made to ophthalmic science, for, while other measures and operative procedures have been introduced to combat this disease, the experience of more than half a century has served to convince the ophthalmic world that this operation is the most potent procedure of all. The distinguished discoverer of the operation was led to the supposition that iridectomy, by reducing the intraocular tension, might be beneficial in glaucoma as a result of the observation that partial staphyloma of the cornea sometimes flattens after iridectomy is performed. As will appear later, the full reason of the efficacy of iridectomy in glaucoma is still in doubt; the fact, however, of the cure of glaucoma, especially in its acute form, by iridectomy is established, and von Graefe must, therefore, be regarded as one of the greatest benefactors of the human race.

Before resorting to iridectomy in glaucoma of an inflammatory type, and particularly if the tension is very high, it is usually desirable to reduce the tension somewhat by other means before entering the very narrow anterior chamber with a knife and excising a portion of the iris. This may be accomplished in a variety of ways. Undoubtedly the surest and quickest of these is posterior sclerotomy, and a number of operators, among whom may be mentioned Priestley Smith and Arnold Knapp, make puncture of the sclera a uniform procedure before iridectomy, the incision being practised, 24 to 48 hours in advance of the iridectomy.

Miotics, too, are of great value, often reducing the glaucomatous process in a few hours sufficiently to permit of operation. They should be invariably instilled into both eyes, as their use in the unaffected eye may prevent a post-operative acute attack of glaucoma, which has been observed not infrequently within a few hours after operation on the affected eye. One or two drops of solution of eserine (gr. i to f. ℥ i) or of pilocarpine (gr. ii to f. ℥ i) may be employed and should be instilled into the eyes every hour, until the pupils become small and the inflammatory signs less. It must be cautioned, however, that even though this plan of treatment causes the glaucomatous symptoms to disappear, it is unwise to postpone operation in the inflammatory types of glaucoma and to rely upon the continuous use of miotics, for, while in a few cases apparently favorable results have been obtained by this means, in the majority the glaucomatous process



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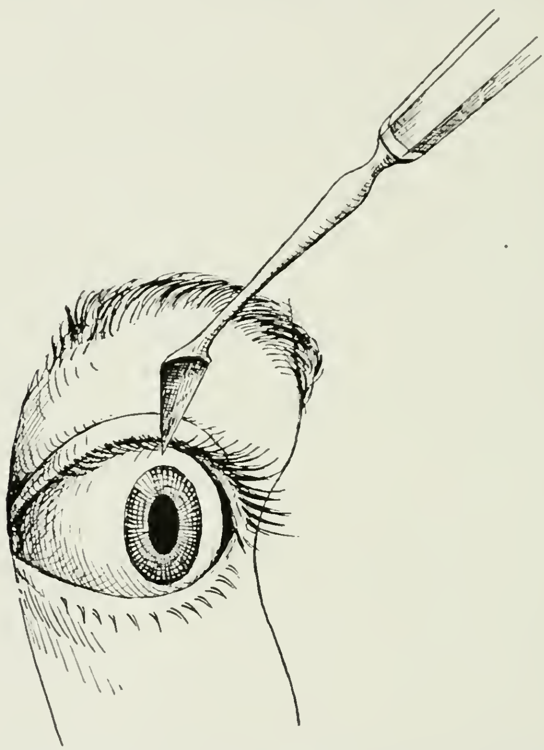
Instruments for Iridectomy. a, von Graefe cataract knife. b, Angular lance knife. c, d, e, Iris forceps. f, Tyrrell's blunt iris hook. g, Curved scissors for excising the iris. h, de Wecker's scissors *(pince-ciseaux)*. i, Combined spatula and blunt-pointed probe.

will develop insidiously in spite of the drug, and the adhesions between the root of the iris and the cornea will become closer, and the excavation in the head of the nerve deeper until vision is hopelessly compromised. Cocaine (3 to 5 gr. to f. ℥ i) may be used in conjunction with the miotics, increasing their action on the pupil and relieving pain (Wood's *System of Ophthalmic Therapeutics*, p. 810). The benefits to be derived from the lymphagogic effects of dionin have been



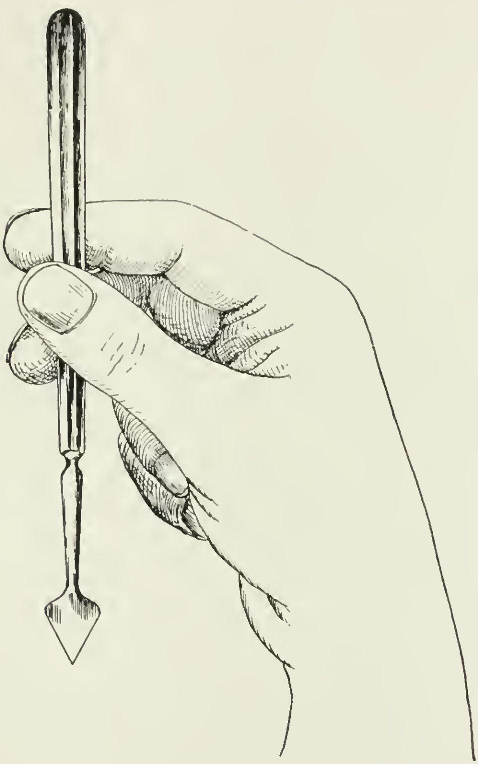
Iridectomy for Glaucoma. Beginning of the Incision.

The lancet is applied slantingly against the sclera at a distance of at least 1 mm.

highly lauded by Peter Callan and Casey Wood and this drug should be frequently instilled in from 5 to 10 per cent. doses. Massage of the eyeball is also of advantage, and hot compresses should be applied almost continually. In addition to these local measures, the patient should be placed in bed, the temple leeched, and morphin and chloral administered internally to relieve pain and secure sleep. Priestley Smith advises a dose of sulphonal or of chloral hydrate an hour before the operation, so as to produce some degree of drowsiness, the

patient then taking ether or chloroform more quietly, and the tendency to vomiting or excitement afterwards being often avoided. Full doses of salicylate of soda should also be administered to control the inflammatory process and relieve pain. The bowels should be freely opened.

Anesthesia in iridectomy. While local anesthesia has the advantage of enabling the operator to gain the co-operation of the patient dur-



Method of holding the bent keratome for incision of the upper corneal margin. (Czermak.)

ing the performance of the operation, and by its use the vomiting, which is often so troublesome after ether, is avoided, it is frequently difficult to produce perfect anesthesia by cocaine on account of the imperfect absorption of the drug by reason of the high tension. General anesthesia, therefore, should be employed unless contra-indicated by some grave systemic condition, in all cases where the glaucoma is of a congestive type, for this procedure, simple as it appears, is one of the most difficult which the surgeon is called upon to perform

and demands that the eye be absolutely quiet until the excision of the iris is completed. Where serious renal or cardiac disease is present, it is usually advisable to delay the iridectomy for a time, and to reduce tension and lessen the inflammatory symptoms by an immediate posterior sclerotomy.

General narcosis should always be employed in children and in nervous and ignorant subjects. Cocaine, 2 per cent., may be used in combination with adrenaline chlorid, 1/3,000, but a miotic should be administered at the same time in cases where the inflammatory symptoms are not pronounced, or where a general anesthetic is contra-indicated.

For the successful performance of iridectomy in glaucoma, certain points are essential. 1. The incision must lie well within the sclera. 2. The coloboma must be of good width; and 3. Some of the root of the iris must be excised. It is also necessary to study the iris carefully before operation, in order that a section may be chosen for excision which is not too highly atrophic.

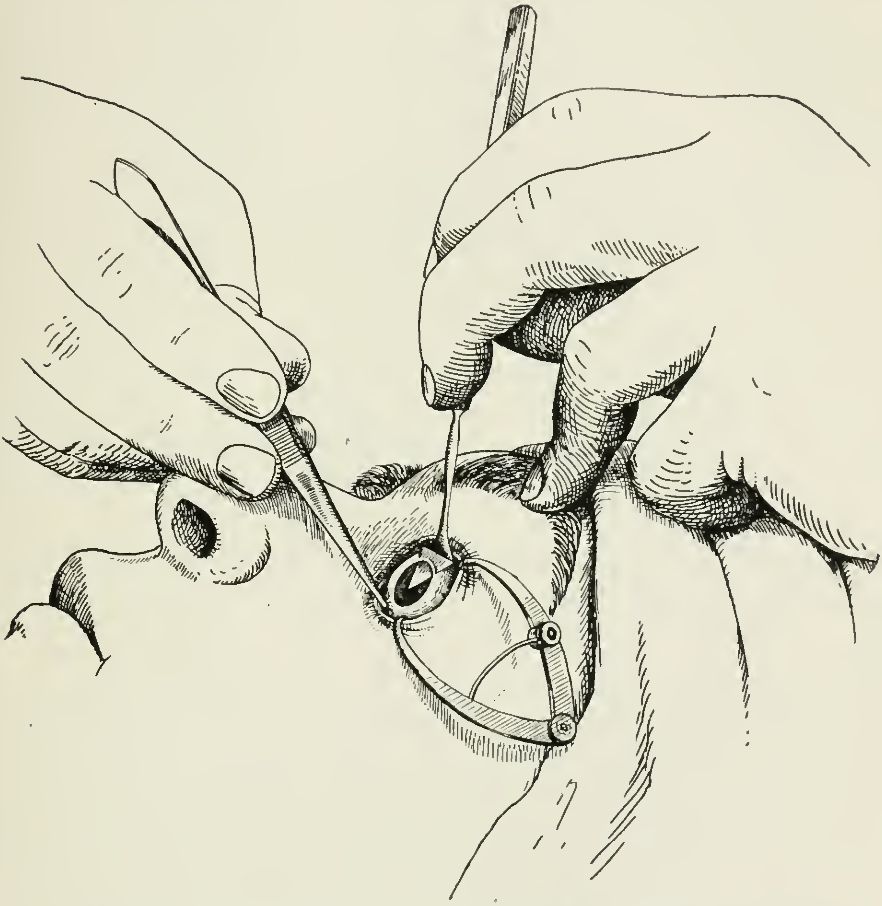
Instruments required. Speculum, fixation forceps (2 pairs), keratome or von Graefe knife, iris forceps, iris scissors and repositor. If the anterior chamber is very shallow, a linear knife with a very narrow blade is to be preferred to a keratome, as the operator can much more readily avoid injury of the iris and lens by his ability to change the direction of the knife and modify the position of the wound, than is the case with the keratome. The keratome has the advantage, however, of making a more regular wound, so that its edges come into better apposition, and by filling the wound until the section is completed, the aqueous is retained as long as possible, avoiding unnecessary prolapse of the iris.

If the keratome be employed, both eyes may be operated upon from behind, but if the Graefe knife is used and the operator is not ambidextrous, the left eye should be operated upon while the operator sits or stands upon the left side of the patient.

First step. The incision. After the introduction of a speculum, the eye is grasped with the fixation forceps near the limbus at a point opposite the site of incision. If the incision is made with a keratome, the blade, which should be quite broad, should be applied somewhat perpendicularly to the sclera 1.5 mm. posterior to the sclero-corneal junction (see the fig.), and cautiously and steadily pushed forwards until the tip of the knife is seen in the angle of the chamber. The handle of the instrument should be held between the thumb and index and middle fingers like a pen (see fig.), the operator steadying his hand by resting the two smaller fingers on the patient's forehead, and

the forward movement imparted to the blade by a simple straightening of the fingers. (See fig.)

After the tip of the keratome is seen in the angle of the anterior chamber, the handle of the knife should be gently depressed, bringing



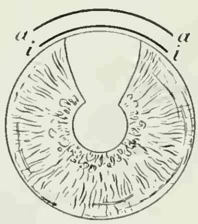
Making the Sclero-iridectomy. The lance-head has entered the anterior chamber. (After Beard.)

the blade parallel with the plane of the iris. The blade is then advanced, care being exercised to maintain the point in the plane of the iris, avoiding injury both to the iris and the cornea. As soon as an incision of 9 to 10 mm. in length is obtained, the handle should be slightly depressed and the instrument withdrawn slowly from the eye, giving the aqueous time to flow off gently. If a wider wound is de-

sired, this may be accomplished by pressing the edge of the blade against the inner or outer angle of the wound as the knife is slowly withdrawn from the eye. This manœuvre should only be resorted to when absolutely necessary, as it is liable to make the incision irregular and thereby interfere somewhat with the prompt and perfect healing of the wound.

Sudden escape of aqueous should always be guarded against on account of the danger of rapid forward prolapse of the lens, which may be followed by rupture of the zonula and luxation of the lens, rupture of the hyaloid membrane and prolapse of the vitreous. In eyes with very high tension, intraocular hemorrhages may also result.

If, instead of a keratome, a Graefe knife is employed, and this—as has been said—is advised when the chamber is extremely shallow, the



Iridectomy in Glaucoma. aa, External orifice of the wound situated in the sclera; ii, Internal orifice situated at the sclero-corneal junction. (Fuchs.)

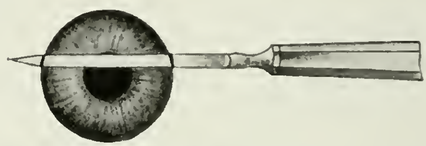
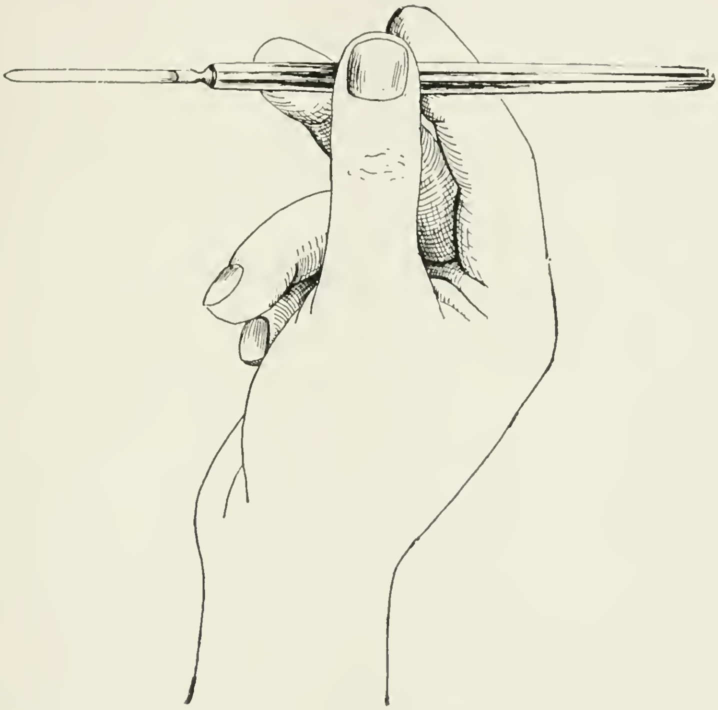


Diagram showing the point of the knife thrust just through at the limbus.

incision is made somewhat similar to that for the removal of cataract, with the important difference, however, that it must be somewhat shorter and must be entirely in the sclera. (See fig.) When ambidextrous, stationed behind the patient when operating on both eyes, or, if not, on his left side when operating upon the left eye, the surgeon steadies the eye by grasping the bulbar conjunctiva with fixation forceps 3 or 4 mm. from the lower limbus of the cornea and introduces a narrow Graefe knife into the sclera about 1.5 mm. back of the corneal limbus, and from 2.5 to 3 mm. above the transverse diameter. (See fig.) As soon as the point of the knife is seen in the angle of the chamber, the handle is somewhat depressed and the blade is pushed slowly forwards in a plane parallel with the transverse diameter of the cornea, the greatest care being exercised to avoid wounding the iris and to make the counter-puncture at the same point in the sclera as the initial puncture. If the chamber is exceedingly shallow, it will be necessary to avoid bringing the knife across the central zone of the

iris, on account of the greater prominence of the lens and iris in that portion than at the periphery of the chamber, and to carry the point of the knife instead around the edge of the chamber, making it describe a segment of a circle between the puncture and counter-puncture. (See fig.) Should the operator fail to pierce the cornea before the anterior chamber has been entered, a so-called intra-lamellar incision will result. If this accident occurs, the knife should be withdrawn and another incision should be made at the site of the first, but with better direction.



Method of Holding the Straight Graefe for Upward Incision. (Czermak.)

As soon as the counter-puncture has been accomplished, the knife is pushed steadily upwards, keeping the wound entirely in the sclerotic, as in the operation of anterior sclerotomy, and is finally made to emerge about 2 mm. behind the limbus. The greatest care must be exercised not to permit the point of the knife to sink too deep into the angle of the chamber, but to keep the point of counter-puncture on exactly the same plane as the puncture, else a slanting incision will result with probable injury to the ciliary body. The conjunctival flap should now be reflected forwards over the cornea to permit of the ready excision

of the iris, being easily replaced in its original position before the toilet of the eye has been completed.

Second step. Seizure, withdrawal and excision of iris. If the operation is being performed under local anesthesia, a drop of cocaine should now be applied directly to the iris, to render it still more insensitive. The operator then takes a delicate pair of iris forceps in his left hand and a pair of iris scissors in his right, relinquishing his hold on the fixation forceps to an assistant who is requested to keep the eye rotated somewhat downward. (See fig.) The iris forceps should be held like a pen, between the thumb and index and middle fingers, the little and ring fingers resting on the supraorbital ridge, the movements of the forceps being executed by extension and flexion of the fingers. (See fig.) The de Wecker scissors are usually preferred to the small scissors curved on the flat, which were previously employed. They, too, like the iris forceps, should be grasped like a pen, by the

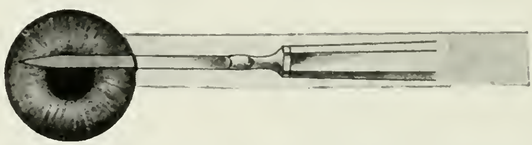
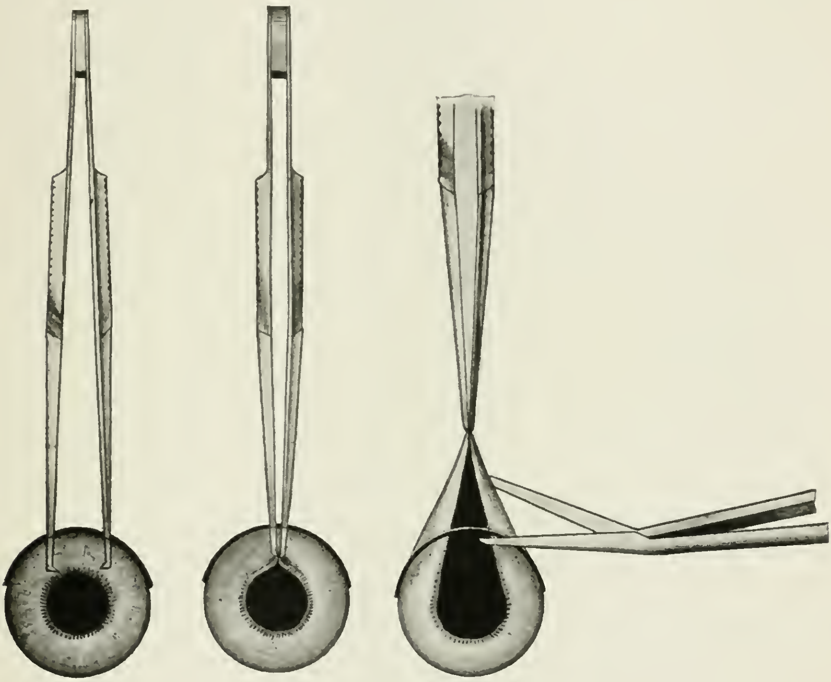


Diagram Showing the Point of the Knife Directed Toward a Point in the Cornea about 1 mm. Within the Limbus, so as to Begin the Counter Puncture.

ball of the thumb and index finger resting on the blades of the handle. With the blades of the forceps closed, the operator cautiously introduces the little instrument into one angle of the wound, and gently opening the forceps, grasps a small fold of iris near the pupillary margin. This portion of iris is drawn outwards into the angle of the wound, and at the moment of strongest traction the iris should be incised as near the base as possible by the scissors, the blades of which should be held parallel with the wound. (See accompanying figs.) The iris is then torn from its base by deflecting the forceps to the opposite angle of the wound, and a final snip given the portion which has been dragged out of the eye. By introducing the forceps in the angle of the wound instead of through the middle of the incision, a procedure which was first practiced by Bowman, it is possible to make the base of the coloboma broader than the extent of the incision, while the peripheral incision of the iris, and the tearing it from its attachment, insures the excision of its root, without which an iridectomy for glaucoma may be considered a failure. Many operators, however, favor snipping the iris with one clip of the scissors, believing the method which has just been described possesses no advantage over the

single cut incision, while it prolongs the procedure and is more painful.

Third step. The toilet of the wound. After the excision of the iris is completed, a delicate iris repositor should be inserted a short distance into the angle of the wound and incarceration of the iris prevented by gently stroking the pillars of the coloboma in the direction of the chamber. The repositor should then be made to traverse the



Steps of the Operation.

The blades of the iris forceps held close to the pupillary margin have just been opened.

The blades have been closed and have seized a fold of the iris.

The portion of the iris, which has been drawn forward, is cut off by the scissors brought from below.

entire length of the wound, to remove blood clots and to smooth out the edges of the flaps. If there be much blood in the anterior chamber it may usually be removed by gently depressing the posterior lip of the wound with the repositor and by stroking the cornea in the direction of the wound. If the hemorrhage continues, it may be necessary to apply a pressure bandage without waiting for its control. If considerable incarceration still persists after the manipulation with the

repositor, further excision of the iris must be resorted to, but great care should be exercised in introducing the forceps a second time to avoid injuring the lens capsule. The iris may be judged to be in proper position and the toilet of the eye completed when the lips of the wound are in perfect apposition and the two pillars of the coloboma are of the same height and situated in the curve of the former pupillary margin. The speculum is now withdrawn, and after eserine has been instilled into both eyes, a compression bandage is applied.

Accidents complicating iridectomy in glaucoma. If the incision has been too short and the opening into the chamber too small to permit of the ready opening of the blades of the forceps, the wound should be enlarged by one short cut of a small pair of delicate curved scissors (Stevens' strabotomy scissors), which should be introduced into the outer angle of the wound.

Transfixion of the iris may occur either immediately after the chamber has been entered, in which event the knife should be slightly withdrawn and then pushed forward more anteriorly, or it may happen when the knife is more deeply engaged in the wound and its withdrawal necessitates loss of aqueous. If this latter occurs, the knife should be entirely withdrawn and the operation postponed until the chamber has reformed, the continuance of the incision being attended with too great danger of irido-dialysis and injury to the lens capsule.

Separation of the iris at its ciliary attachment to a greater or less extent, and even complete detachment, may occur if the patient make a sudden movement of the eye and the operator is not quick to release the iris from the forceps. Severe hemorrhage usually follows, which obscures the field of operation and prevents the proper toilet of the wound. As a rule, however, the blood is rapidly absorbed and only in rare cases is the blood clot converted into a dense cicatrix which occludes the pupil and contracts the coloboma.

It sometimes happens that the sphincter is not included in the excised portion. In this event a blunt hook should be inserted parallel with the anterior surface of the iris, and the narrow bridge of tissue broken through by traction with the hook, or divided with scissors after it has been brought out of the eye.

If the aqueous is evacuated too suddenly, the abrupt lowering of the intraocular pressure may occasion choroidal hemorrhage, rupture of the zonule and hyaloid, presentation of vitreous and subluxation of the lens. When, however, none of these disastrous consequences follow, and the iris alone is prolapsed into the wound, rather than excising the protruding membrane at once, Czermak advises replacing it before proceeding, in order to correctly gauge the amount of iris to

be excised and to properly fashion the coloboma. He recommends excision without previous replacement, however, when the conjunctiva is so inflamed as to entail danger of infection; when the tension is high; when the lens is dislocated or abnormally small, as in hydrophthalmus, or when the vitreous is presenting; and in nervous persons and children who are under local anesthesia only.

Spontaneous rupture of the lens capsule may occur as a consequence of increased vitreous tension, immediately after completing the scleral incision or later with spontaneous discharge of the lens nucleus. More frequently the injury to the capsule is occasioned by the knife or by the forceps, but, even in the latter event, traumatic cataract of greater or lesser extent follows, which interferes with vision or is attended with even more serious consequences.

Luxation of the lens may follow rupture of the zonule either from too abrupt discharge of the aqueous, as has already been mentioned, or it may result from pressure by the instrument or from faulty manipulation. The edge of the lens is at once forced into the angle of the wound or into the coloboma if the iris has already been excised. Increase of tension follows and malignant glaucoma may result.

For the relief of this condition de Wecker (*Chir. Ocul.*, p. 155) advised a sclerotomy opposite to the coloboma, the lens being replaced by pressure on the upper lid while the knife is still in the wound. Weber's procedure (*Arch. f. Ophthalm.*, XXIII, Part 1, p. 86) for the same purpose is more complicated. This operator counselled making a puncture 8 to 10 mm. from the external limbus in the horizontal meridian of the eye with a double-grooved, so-called broad needle, the needle being rotated on its axis one-fourth to make the wound gape. The lens is then replaced by gradual increase of pressure on the upper lid or by a cataract spoon applied to the cornea perpendicular to the surface of the coloboma, the usual site of the luxated lens. A high degree of pressure should be maintained for a minute or more to permit of the re-accumulation of the aqueous. A slight pressure bandage is applied and the patient placed in the supine position for 24 hours.

Weber insists that the operation should be undertaken from 10 to 20 days after the luxation, the cicatrix being then sufficiently strong to withstand the pressure. If postponed until later, adhesions are apt to form between the lens and the iris and cicatrix which complicate the procedure, and in addition the eye is subjected to the danger of continued high tension.

If vitreous presents following rupture of the zonule before the excision of the iris and results in a sudden deepening of the chamber,

as it escapes from the wound, the attendant prolapse of iris should be immediately excised, the iris being drawn out of the wound by means of a blunt hook. Both speculum and fixation forceps should be dispensed with, the lids being fixed by an assistant. If the prolapse occurs after the iris has been excised, the operation should be discontinued and, if considerable vitreous presents, it should be snipped off with seissors.

After very bungling operations the lens may prolapse into the wound and may subsequently become incarcerated, hernia lentis (phakocele), and extraction may have to be resorted to.

Slow closing of the wound after iridectomy for glaucoma is always a serious complication, the attending reactive inflammation usually abolishing all the advantages which the operator had hoped for, the coloboma being choked with inflammatory material, the pillars of the coloboma incarcerated, and the eye slowly passing into a state of iridocyclitis or absolute glaucoma.

After-treatment of iridectomy for glaucoma. While some operators prefer a binocular bandage, a compress bandage upon the operated eye alone suffices, unless the patient is intractable and persists in rolling the unbandaged eye about and repeatedly opening and shutting it, thereby disturbing the operated eye. Under these circumstances both eyes should be closed. The patient should be confined to bed, but not necessarily in the supine position. If no incarceration of the iris is feared, the bandages should not be removed for 48 hours, when the lips of the wound will generally be found to be united and the anterior chamber reformed. The sclera adjacent to the wound is usually somewhat injected and the cornea may exhibit a delicately striated opacity. If at the first dressing the chamber is found reformed, the patient may be permitted to sit up by the side of the bed, and, if the process of healing continues favorably, he may be permitted to walk about at the end of another 48 hours. The bandage should be maintained for ten days, unless it gives rise to conjunctival irritation, when it may be removed earlier, the eye being protected from the light by dark glasses.

It is usually the custom to instill miotics into the operated eye, as well as its fellow, at the time of the operation, and to continue the instillation at each dressing. Czermak, however, advises against this, as he argues that the miotic, by reducing the tension, may obscure an unsuccessful result from the operation, and may permit the eye to pass into a condition of unsuspected chronic glaucoma, which would have asserted itself earlier if no miotics had been employed, and might have been relieved by a second operation.

Complications during the healing process in iridectomy. Delayed union of the wound may be caused by overlapping of the edges or by hemorrhages from the blood vessels of the iris or choroid. A continued compress bandage will usually overcome the latter difficulty unless it be caused by choroidal hemorrhage, in which event the eye is generally lost from irido-cyclitis.

When the incision has been made with a Graefe knife and a long conjunctival flap obtained, the edge of the wound may be kept separated by the fold of conjunctiva. Smoothing out of the flap and the application of the bandage will overcome this complication.

Incarceration in the wound of portions of the iris or prolapse of the lens or of the vitreous may interfere with the proper closing of the wound and may give rise to broadened, often imperfectly formed, fistulous cystoid cicatrices, ectasia of the broadened cicatrix, or of the prolapsed iris with their sequelæ.

Tension may still remain high after iridectomy, and the anterior chamber be obliterated owing to a luxation of the lens or choroidal hemorrhage.

An expulsive hemorrhage of the choroid may follow the sudden decrease in tension and the eye be lost by atrophy. In other cases a gradual increase in tension supervenes without inflammatory symptoms and the eye passes into chronic glaucoma. In such cases iridectomy must be repeated, followed by a sclerotomy or cyclodialysis, if necessary.

If the secondary rise in tension depends upon one of the margins of the coloboma becoming incarcerated in the lips of the wound, the liberation of the attached iris should be essayed by inserting a Graefe knife at one angle of the scar, carrying it through the anterior chamber until it reaches the other side of the site of adhesion and then bringing it out as far in the periphery as possible. The incision should then be completed with sawing movements. If the iris has not been separated from the cicatrix by this incision, it should be dragged out of the wound by iris forceps and as large a piece as possible excised.

Iritis and irido-cyclitis may follow iridectomy. The inflammation is usually of but a mild grade; in other cases, however, due to infection of the uvea at the time of operation or to a traumatic exacerbation of a previously existing insidious inflammation, the inflammation may assume a grave type and occlusion of the pupil and coloboma may follow, destroying the effect of the operation.

Panophthalmitis is very rare, and, when it occurs, takes the same course as that observed after cataract operation.

Theories to account for the efficacy of iridectomy. The manner in

which iridectomy reduces intraocular tension in glaucoma is still unsolved. Graefe himself attributed it to the reduction of the supposed secreting surface of the iris, but this theory has been disproved by the observations of a number of investigators who have shown that the iris has but little to do with the secretion of the intraocular fluid, the ciliary body being practically the sole source. In recent years careful microscopical study of glaucomatous eyes upon which iridectomy had been successfully performed for the relief of tension, but which were later enucleated on account of some intercurrent affection, has shown that in these eyes either the obstructed passage for the exit of fluid at the angle of the anterior chamber was found opened up, or a new channel of exit had been established by the formation of what is termed a cystoid cicatrix.

After a lengthy presentation of the many theories which have been advanced since Graefe's epoch-making discovery, Czermak *(Die Augenaerztlichen Operationen)* finally summarizes the situation as follows: "Typical iridectomy with corneoscleral incision abolishes glaucoma by separating the iris from the trabeculæ in the region of the wound and establishing at this point a permanent opening in the iris. The essential feature of the coloboma is its peripheral position. Iridectomy may also be efficacious by causing a detachment of the adjacent iris tissue. When this occurs and there is incarceration of the base of the iris and non-separation of the iris in the region of the wound, vicarious drainage is assured and a favorable result attained. Typical sclerotomy with clean, scleral incision, abolishes glaucoma by reopening the natural outlet of the intraocular fluid, in consequence of incision of the adherent iris and of its ligament." Czermak regards an iridectomy with a clean scleral incision as being nothing more than a sclerotomy with excision of the centrally situated portion of the iris. Irido-sclerotomy, the incisione dell'angolo irideo and sclerotomy act identically. Czermak thinks it is almost impossible to establish by operative means an entirely new channel of exit in cases where the natural channels have been permanently closed.

Prognosis after iridectomy. In view of these facts, it is evident that the prognosis for the restoration of vision after iridectomy depends upon the variety of glaucoma and the duration of the disease. In the acute and subacute inflammatory types, it may be said to exercise a curative action, and this is true in proportion to the time that the operation is performed after the appearance of the attack. If performed early, when the blocking of the chamber is due to vascular congestion and not to permanent causes, the filtration angle may be permanently opened, and the disease actually cured. In acute fulmi-

nating glaucoma the results of operation in recent cases are especially favorable, and if iridectomy is performed soon after the outbreak of the inflammatory attack, a degree of sight is secured which is somewhat, but not much, smaller than it was before the attack, and the good results are permanent. The operation must be performed early, however, for if it is delayed and there has been no perception of light for two or three days, the chances of restoration of vision are very small. Full vision may, however, be regained after even some hours of absolute loss of light perception. In a certain small proportion of cases (malignant glaucoma) iridectomy, even if repeated or associated with sclerotomy, will not control the process, and blindness will ensue. As has been mentioned, operations done in the prodromal stage give particularly favorable results, so that this may be regarded as the time of election for iridectomy in inflammatory glaucoma.

The prognosis for conservation of vision after iridectomy in subacute glaucoma is also favorable, and the operation should always be resorted to, though the emergency for an immediate operation is not so great, since miotics may hold the disease in abeyance for a time. It must be cautioned, however, that the continued use of these drugs in any form of inflammatory glaucoma is to be deprecated, as any permanent effect upon the progress of the disease can be secured by operation alone.

Wygodski's (*Klin. Monatsblätter f. Augenh.*, 1902, XLI, II, p. 177) table of results after iridectomy for acute glaucoma show that the prognosis was favorable in 80 per cent. of the cases. Of 237 cases of glaucoma of all types iridectomized by Grosz, success was obtained in 96 per cent. operated in the prodromal stage and in 87 per cent. operated in the active stage.

Iridectomy of most value in the acute forms of glaucoma. While advocated by many surgeons, experience has shown that iridectomy is not as efficacious in the relief of tension in chronic non-inflammatory glaucoma as in the more acute varieties. This is doubtless due to the completeness of the adhesions in the angle of the chamber, which form as a consequence of the long-continued increased pressure within the eye, rendering the removal of the root of the iris and the opening of the spaces of Fontana, by operation, impossible. Be this as it may, many operators have abandoned iridectomy in chronic glaucoma and have sought to cure this type of the disease by other surgical procedures, the majority of which have for their aim the creation of a means of filtration for the intraocular fluids out of the eye, by the production of more or less patulous cicatrices. Several years ago, removal of the cervical sympathetic ganglion was favored by a few operators

as a means of reducing tension in chronic glaucoma, but the operation was never widely practised and is now practically never performed.

Miotics versus operative measures in chronic glaucoma. Of late years there has been an increasing number of ophthalmologists who have expressed the conviction that the operative form of treatment is not the only means of combating the increased tension of chronic glaucoma, and the continuous use of miotics has been widely extolled in the management of this non-inflammatory form of glaucoma. The writer (*Journal of the A. M. A.*, 1907, XLVIII, p. 676; *Ophthalmology,* April, 1907; *Journal of the A. M. A.*, Oct. 24, 1908, Vol. LI, pp. 1389-1394) has long been an advocate of this form of treatment, and in several communications has emphasized the beneficial effect which may be derived from these drugs. In a late paper he analyzed the histories of 65 cases of a pure type of simple chronic glaucoma, of which number all but 7 had used a miotic continuously for over a period of two years, and 12 for more than 10 years. As most investigators of simple chronic glaucoma urge the necessity of early operation in this type of the disease, as well as in the inflammatory, and as it is generally recognized that the treatment and the prognosis of chronic glaucoma are much influenced by the stage in which the disease comes under observation, the cases were divided into three classes, according to their degree of development: (1) Beginning cases. (2) Moderately advanced cases. (3) Very advanced or desperate cases. Of the 110 glaucomatous eyes which could be studied for statistical purposes, it was found that vision had improved or held its own during the entire time the case was under observation in 80 per cent., that there had been a slow deterioration of vision, both central and peripheral, in 11.8 per cent., while in 8 per cent. the miotics seemed to exert no influence, the eyes going blind and passing into absolute glaucoma.

[V. Hippel (*Klin. Monatsbl. f. Augenheilk.*, July, 1907; review by Blair in the *Oph. Review*, p. 21, Jan., 1908) upholds the generally accepted opinion that iridectomy is not only justifiable, but that the ophthalmic surgeon is bound to recommend it, and to give his patients the benefit of the only treatment which, in his opinion, is calculated to restrain the progress of the disease. Ophthalmic surgeons, however, do not all agree on this point. De Wecker obtained the opinions of 120 experienced operators, and found that nine-tenths favored, while one-tenth opposed, the operation; but Pechin, after a similar investigation, came to the opposite conclusion, namely, that the majority of operators considered it of little or no use. Both Schleich and he believe that the only treatment of any avail is the

regular use of miotics. Schleich mentions that all statistics of operative treatment in simple glaucoma become more and more unfavorable in proportion to the length of time during which the cases are under observation.

The evidence v. Hippel brings forward is altogether in favor of iridectomy, and he considers that it distinctly retards the progress of the disease. In his clinic 41 per cent. of the cases operated upon showed no aggravation of symptoms after two years; 20 per cent. showed none after five years; 14 per cent. after ten years; and 9 per cent. after fourteen years.

Von Hippel points out that these favorable cases were not all operated on in the early stages of glaucoma, but that many had markedly contracted fields and pronounced cupping of the disc. He also states that in no case was the acuity of vision diminished by the operation. He condemns the use of miotics before operation if it leads to any delay, but thinks the iridectomy should be done as soon as the disease is diagnosed. Miotics, on the other hand, should be used regularly and continuously after operation. Sclerotomy also, the writer maintains, ought never to be employed as a substitute for iridectomy, but should be reserved for a secondary operation in case the tension rises after iridectomy. Even in advanced cases of simple glaucoma he considers that iridectomy should be performed, and that even then it tends to defer the advent of blindness.

A report on the value of iridectomy, based upon an analysis of 1,200 operations, is furnished by Hallauer (*Archives of Ophthalm.*, July, p. 436, 1908), who takes up the results of this operation, in so far as it applies to the cure of glaucoma. He says that in acute glaucoma, iridectomy was followed by diminished vision in 2.6 per cent. of the cases. In 35 per cent. there were relapses, which in most cases could be controlled by miotics. Sixty-nine per cent. were improved. Vision remained the same in 12 per cent., and was diminished in 18 per cent. In chronic inflammatory glaucoma, operation was followed by recurrences in 19 per cent., of which 12.5 per cent. were controlled by miotics. There was improvement of vision in 35 per cent., diminution in 39 per cent., and no change in 26 per cent. In glaucoma simplex, tension was reduced to normal in 80.5 per cent. Recurrences occurred in 31 per cent. A second iridectomy was necessary in 6 per cent. Three per cent. ran a malignant course after the operation. When a glaucoma iridectomy in one eye is followed by a malignant course of the glaucoma, iridectomy should not be performed on the second eye. Of seven cases of absolute glaucoma operated on on account of pain, five improved. In hydrophthalmus two operations resulted in a dimi-

nution of tension, with preservation of vision. In one case a second iridectomy was necessary. In hemorrhagic glaucoma, iridectomy is contraindicated. In two cases in which it was done as a last resort in place of enucleation, pain was relieved, but there was diminution of vision.

Macnab reports a case of glaucoma which he had the opportunity of observing long years after iridectomies had been performed for its relief, in one eye 39 years and in the other eye 34 years prior to his investigation. He found the vision apparently the same as it was immediately after the operation, and that, too, in spite of the tension being fairly high in one of the two eyes.

Minor operated on a patient aged 57, who had been blind for nearly a month as the result of glaucoma. The double iridectomies restored vision, which at its best rose to 20/30 and 20/40, respectively.

Wölfflin leaves the sphincter pupillæ intact in doing iridectomy for glaucoma, believing that the subsequent use of miotics will be more effective, and the edges of the coloboma will be less apt to prolapse into the wound during the healing process. He reports three successful operations for chronic glaucoma. The same operation has been proposed by Pflüger and Snellen. Diplopia was not complained of by the patients. Ed.]

Treatment of hemorrhagic glaucoma. Owing to the sublying arterial sclerosis which is present in cases of hemorrhagic glaucoma and the danger of hemorrhage following the diminution of intraocular tension, iridectomy is seldom practised in this variety of glaucoma, less radical surgical measures, conjoined with the use of miotics, and remedies directed to the sublying physical condition, being preferred. Thus Bull recommends a careful corneal paracentesis, after complete cocainization, the aqueous being permitted to flow out only drop by drop from the anterior chamber. The temple is then leeched, after which a solution of eserine sulphate, one grain, and pilocarpine hydrochlorate, four grains, to the ounce, is instilled every hour until the eye softens. Hot compresses are then applied until all pain has disappeared. Twenty drops of the fluid extract of jaborandi are prescribed three times daily to lower intravascular tension. Repetition of the paracentesis may be necessary. A careful regimen of the life of the patient must be enjoined.

On the other hand, Weekers (*Ophthalmic Year Book*, 1909, p. 211) does not believe that iridectomy is always contraindicated in hemorrhagic glaucoma. He thinks that there are two distinct classes of this type of the disease, one with marked degeneration of the intraocular vessels, readily ruptured by the sudden release of the intraocular

tension following an iridectomy, and another class of cases in which the vascular changes are not so marked. In this latter class iridectomy relieves the action of hypertension in the blood vessels and permits the repair of existing vascular lesions.

Treatment of buphthalmus. The treatment of this condition is very unsatisfactory. Miotics are of but little avail and no form of surgical intervention has been devised which can cure, or even check, the process. Iridectomy is not followed by good results, nor have its substitutes proven of service in this destructive form of glaucoma. The best results seem to be attained by repeated posterior sclerotomies.

Treatment of secondary glaucoma. If the rise of tension be but temporary, as in traumatic cataract or serous iritis, paracentesis of the cornea will suffice to relieve the glaucoma. If, on the other hand, the glaucoma is due to definite anatomical conditions which occasion a blocking of the angle of the chamber, more radical measures are necessary, and different procedures will have to be resorted to, to relieve the various sublying causes which have been mentioned elsewhere.

If this form of glaucoma is consequent upon the blocking of the angle of the chamber from anterior synechia, the operation of synechiotomy (*vide intra*) is advised. When the rise of tension has been caused by seclusion of the pupil, iridectomy is indicated, the glaucoma being relieved by the re-establishment of a normal circulation between the posterior and anterior chambers. The removal of the iris is very difficult, however, in cases of total posterior synechia, and is often unsuccessful. If iris bombé is present, Fuchs' operation of transfixio iridis is the operation of choice.

In secondary glaucoma after wounds and operations due to prolapse of lens capsule, or hyaloid membrane of vitreous, between the lips of the corneal wound, tension may usually be relieved by carefully dividing the prolapse with a sharp knife-needle.

When the glaucoma has been occasioned by a dislocation of the lens into the anterior chamber, this structure should be cautiously removed by an incision with a Graefe knife, after the pupil has been contracted as much as possible with eserine. Some loss of vitreous usually follows this procedure.

If the increase in tension has been set up by a lens that has been luxated into the vitreous, the removal is attended with still greater danger of loss of vitreous, and is best accomplished by first bringing the lens into a normal position by a needle passed posteriorly through the sclera and then removing it by means of a scoop.

Modifications of the procedure of iridectomy. Although favoring

the linear knife, Scherk (*Klin. Monatsbl. f. Augenheilk,* 1873, p. 101) thought the lancet more practical in certain cases. To combine the advantages of both these instruments, he devised a bayonet-shaped knife with a blade 15 mm. long inserted at a little more than a right angle into a 20 mm. long shank, which is fixed again at a little more than a right angle into an ordinary knife handle.

Czermak is a warm advocate of a method practised by Dehenne (*Arch. d'Ophtal.*, 1888, p. 120), especially in primary glaucoma with a shallow or obliterated anterior chamber and in iris bombé. This operator punctured the outer inferior quadrant of the globe 1.5 mm. from the limbus with a very fine linear knife. The sclera is perforated until the point of the knife appears in the angle of the chamber. The scleral incision is then enlarged parallel to the limbus 4 to 5 mm. by slow sawing movements of the knife. No counter-puncture is made. During this maneuvre the aqueous escapes drop by drop and tension is reduced very gradually. The iris is then withdrawn and excised. Czermak makes his incision in the upper, outer quadrant and usually fixes the eyeball with two pairs of forceps.

Streatfeild (*Congrés de Londres,* 1873, compt. rend., p. 154-159) also avoided counter-puncture and made much the same incision as Dehenne, employing the point of a broad cataract knife for the purpose.

Deschamp's method (*Anal. d'Ocul.*, 1902, CXXVII, p. 101) of making an incision through the limbus and adherent iris, thus re-opening the posterior chamber, seizing the posterior surface of the iris and then withdrawing and excising that membrane, also resembles Dehenne's.

Gayet (*Bulletin. et Mem. Soc. Franç. d'Ophtalm.*, 1884, p. 41) has devised an operation which has been somewhat modified by Dufour (*Annales d'Oculist.*, Jan., 1901), which is applicable to cases in which the anterior chamber is so shallow that it is impossible to open it without wounding the iris if the ordinary plan of incision is followed. In this procedure the surgeon grasps the conjunctiva with Monoyer's fixation forceps, applying one point above and the other below the cornea. The incision is then made at the scleral-corneal junction with an ordinary Desmarres scarificator through the cornea from without inwards, the membrane being divided layer by layer by gentle sawing movements, care being exercised to keep the knife constantly in contact with the tissues to prevent the incision from becoming jagged. As soon as a drop af aqueous presents, the scarificator is dispensed with and the incision is finished with small, blunt-pointed scissors, or, as recommended by Dufour, with small, bent knives (iridesis knives).

The excision of the iris now follows in the usual manner. General anesthesia is desirable. Gayet deemed his procedure particularly adapted to cases of acute glaucoma with opaque cornea. The complications consist in hemorrhage into the anterior chamber and injury of the iris by the scarificator, but the blood is rapidly absorbed, and if the iris is injured, it can readily be excised.

Dianoux (*Bull. et Mem. de la Soc. Franç. d'Ophtalm.*, 1884, p. 44) substituted a Beer's knife for the scarificator and a Weber probe-pointed lachrymal knife for the seissors. Beard (*Ophthalmic Surgery*, p. 446) suggests that a little instrument, one less likely to wound the iris, would be a small model of the Desmarres keratome.

When the anterior chamber is very shallow, Czermak cuts the conjunctiva close to the limbus with fine-pointed scissors, and dissects back a flap embracing nearly one-half of the corneal circumference and about 4 to 5 mm. high at the center. After checking any slight hemorrhage with adrenaline and ice cold sponges, he makes an incision with a well-curved scalpel, through the sclera, 1 mm. from the edge of the clear cornea, cutting carefully, layer by layer, until the anterior chamber is opened. If the iris prolapses, it is replaced, and the well-rounded point of a fine Louis' scissors is introduced, and the incision broadened to one or both sides. The original incision needs to be only large enough to admit the scissors' point, and should be slightly oblique instead of vertical, the back of the knife being inclined almost toward the equator of the ball. In this way the inner wound is almost exactly opposite the boundary of Descemet's membrane, and a coloboma 4 to 8 mm. wide can be secured. After introducing the iris forceps, they are opened wide so as to secure a broad fold of iris, the iris is grasped in the center and drawn gently toward the pupil, the forceps being pushed forward. This loosens the ligament, and the iris is then drawn outward and excised.

In cases in which the iris is adherent to the cornea, and is more or less atrophic, Czermak combines Heine's cyclodialysis with the iridectomy. Following Heine's method, he frees the attachment of the ciliary body and the adhesion of the iris with a delicate spatula, and then performs the iridectomy. He has done the combined operation in a number of cases, but is unable to make a definite report upon its results. In order to avoid seizing the ciliary body with the forceps, if it prolapses into the wound, he has had constructed a forceps with protecting plates. Usually at the conclusion of the operation he passes a silk suture through the edges of the conjunctival wound, and if the ciliary body prolapses he makes a superficial scleral puncture.

In cases of acute glaucoma with abolition of the anterior chamber

and the iris reduced to a narrow rim or wholly lost to sight beneath the corneo-scleral margin, Burnett (*Am. Journ. Ophthalm.*, April, 1902, p. 114) modified the incision after the method originally introduced by Streatfeild in his operation for cataract, as follows: An opening is made into the anterior chamber from without, by successive strokes with the point of a Graefe knife, following the curves of the corneal base as far behind the clear cornea as desirable for the most peripheral position of the wound, the essential idea being to cut the layers at the sclero-corneal junction as evenly as possible throughout the whole extent of the incision. The bottom of the wound thus carefully made, finally gives way at some point, and through this opening there is a gush of aqueous and usually a prolapsed iris. A triangular knife with a bulbous point is then introduced into the wound and the section of the already thinned tissue completed by the sharp sides of the knife. The iris now usually occupies the opening and is seized with the forceps and cut in the usual way.

A. A. Bradburne has adopted the plan (when operating for quiet, simple glaucoma) of removing only the base of the iris, taking particular care to leave intact the periphery. To do this well he finds it advisable, after the usual incision has been made with a keratome, to grasp the center of the iris and to make gentle traction to the center of the pupil so as to first dislocate the root. It is then withdrawn and cut off in the usual manner.

The advantages of this modification are, (1) it produces little disfigurement, (2) it causes very little shock, (3) it does not destroy the optical properties of the iris as regards its light-protecting or visual properties, (4) it does not allow the iris to fall back into the anterior chamber as the more drastic operation does, (5) it lessens the need for so large an incision and therefore lessens the liability to prolapse of the lens, corneal astigmatism and, finally, does not prevent other operations being performed if necessary later on. Personally, he has never found occasion to do anything further in any case in which he has employed it.

Sclero-iridectomy. Terson, Sr. (*Mémoires du Cong. d'Opht. de Paris*, Jan. 26, 1885; *Société de Med. de Toulouse*, Jan. 11, 1889) aimed at insuring the beneficial action of both operations by combining iridectomy with sclerotomy—sclero-iridectomy. A sclerotomy is first performed after the method of de Wecker, the puncture, however, being made much higher, in line with a point 2 to 3 mm. from the upper end of the perpendicular corneal margin, the counter-puncture as a consequence occurring only slightly above the nasal extremity of the horizontal meridian. The incision is continued with

sawing movements and the wound of entrance is made much longer than that of the counter-puncture by raising the handle of the knife. To prevent the partially divided conjunctiva over the wound of entrance from interfering with the excision of the iris, the knife is thrust forward a second time after withdrawal and a portion of the conjunctival bridge divided. The flap thus formed is reflected over the cornea, and the iris then drawn out and excised as peripherally as possible. A resultant narrow coloboma is thus secured above.

This operation resembles somewhat the sclero-dilatatorectomy of Logetschnikow (*Bericht über die 23 Versammlung der Ophthal. Gesellsch.*, Heidelberg, 1893, p. 21), in which the operator aims to perform iridectomy with preservation of the pupillary margin in combination with double sclerotomy. If the iris is merely incised, the operation should be designated sclero-dilatatorotomy.

Filtering cicatrix. As has already been stated, de Wecker long ago suspected that it was not the removal of the iris which diminished the intraocular tension in glaucoma, but rather the formation of the "filtering cicatrix." In recent years this theory has gained many adherents, and ophthalmological journals have contained a remarkable number of diverse methods to obtain filtration areas. While there are still those who believe that a soundly-healed cicatrix possesses filtration properties, the majority of observers, perhaps, have now arrived at the conclusion that such is not the case, and consider that a firmly-healed cicatrix in the sclera is no more permeable than normal tissue. The newer procedures, therefore, aim at the removal of some of the sclera, in the hope that the remaining parts, even after healing, will be permanently less resistant, and will thus allow the intraocular fluids to pass more rapidly from the eye.

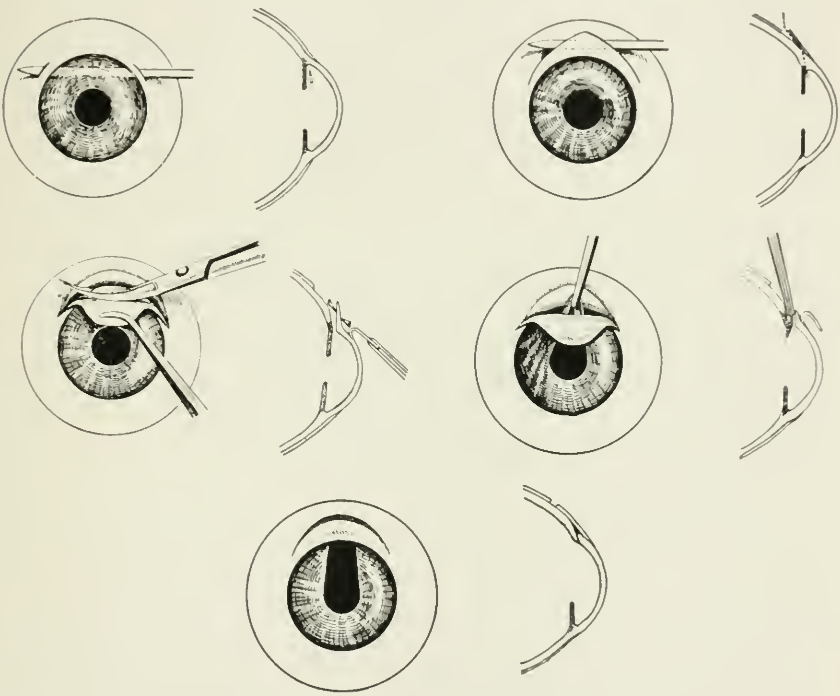
[B. James and S. Hosford (*Trans. Oph. Soc. U. K.*, July, 1912) report a description by Mr. James in 1909 of a method of operating upon all cases of glaucoma by cutting through the sclera from without, after having turned down a preliminary conjunctival flap to cover over the linear wound. Since then the operation has been somewhat elaborated by turning out a piece of sclera by the following method: The conjunctiva having been made anesthetic, and a few drops of adrenaline solution instilled, a large conjunctival flap was turned downwards to the corneal margin. All further bleeding was now stopped by adrenaline. An incision was next made at the limbus, concentric with the corneal margin, by cutting with the edge of the Graefe knife near its tip, so that the lips of the wound were perpendicular. The paring was proceeded with until a fair depth of wound had been obtained. A small puncture was then made, and the aqueous allowed

to evacuate itself very slowly. A blunt-pointed Stilling knife was now inserted into this opening, and the wound enlarged throughout its extent. A moderately large iridectomy was then made in the usual way. The operator then proceeded to turn out a piece of sclera from the upper lip or the angles of the wound, endeavoring to ensure that some of the lining membrane was attached to its under surface. This was laid flat on the surface of the adjoining sclera, and held in position by the conjunctival flap being stroked over its surface. The special points in the operation were: (1) The fact that the edges of the scleral incision were perpendicular, not slanting as made by the Graefe or the keratome. (2) It would be noticed that the iris fell backwards much more readily than in an ordinary iridectomy, and did not require the introduction of another instrument into the eyeball to replace it. (3) The scleral flap could be cut by one of two methods. In some of the cases this was done by means of a punch. This, however, was somewhat uncertain, and occasionally punched a piece of sclera clean out, which was not desirable. (4) Another method was to turn outwards by means of scissors or knife a strip from one or both angles of the wound. If this plan were adopted it was better to outline a strip by marking out its limits almost through the whole thickness of the sclera prior to opening the anterior chamber, as the relaxed state of the tissues when the aqueous had escaped rendered the proceeding more difficult. Hosford carried the method out in all his cases of glaucoma except one, and that he did on the periphery of the iris. Whatever method was employed there was a predilection on the part of the sclera to close up. Ten out of 38 cases so treated closed up. Of the 38, 28 leaked by first intention and 8 of the remaining 10 leaked secondarily. The operation was simple. Ed.]

One of the chief opponents of the theory of filtering cicatrices is Henderson (*The Ophthalmoscope,* Dec., 1907, p. 701), who contends that the success of the operative procedure in glaucoma does not result from the particular method of incision adopted, but depends, as has been well shown clinically since Graefe's time, on the iridectomy and on the state of the iris. He bases this statement upon anatomical investigations, which demonstrate, in his opinion, that while corneal incisions heal and cicatrize, the cut iris surface forming the base and pillars of the coloboma never does, but always remains as when first severed, thus acting as a drainage area, the efficacy of which depends on the condition of the iris at the time of operation. Thomson and Grimsdale (*The Ophthalmoscope,* Nov., 1908, p. 875) give an impartial review of the question of the so-called filtering cicatrix. Quite recently, also, Ballantyne (*The Ophthalmoscope,* July 1, 1910, p. 507)

has contributed an extremely valuable paper upon the same subject, and has given a most lucid review of all the newer operations for glaucoma.

The Lagrange irido-sclerotomy operation. Of all the operations designed to establish a filtering cicatrix, that devised by Lagrange (*Révue générale d'Ophthal.*, 1906, p. 358; *Arch. d'Ophtalm.*, 1906, XXVI, p. 481) and designated by him as irido-sclerotomy, or iridectomy combined with sclerotomy, has probably met



Illustrating Different Steps in the Lagrange Operation.

with the greatest favor. To obtain this permanent filtration cicatrix, after eserinization, an oblique incision is made through the sclera by means of a narrow Graefe knife and a large conjunctival flap secured. This is obtained by making a peripheral section of the sclero-corneal margin with the knife, and, as soon as the edge of the knife reaches the upper limit of the anterior chamber, it is turned backward and brought out through the sclera obliquely (see fig.). The conjunctival flap is then turned back over the cornea, and the fragment of sclera that was left attached to the cornea is removed by means of a fine pair

of delicate curved scissors (see fig.), following which an iridectomy is performed. The conjunctival flap is now replaced and a bandage applied. This operation opens a large filtration passage for the intraocular fluids and the prompt healing of the wound with its mucous covering prevents prolapse of the iris.

Although Lagrange advocated iridectomy in all cases in his first communication, he no longer judges the procedure to be necessary in all instances, reserving it for cases in which for any reason, such as hypertension, prolapse is to be feared. Under no circumstances must the iris be left between the lips of the wound.

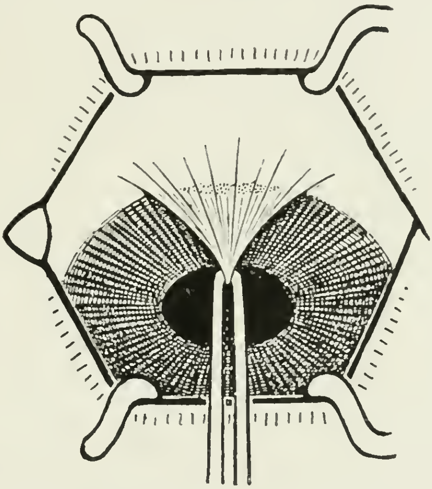
While Lagrange holds that it is necessary to open the anterior chamber, Bettremieux (*Bull. de la Soc. Belg. d'Ophtal.*, No. 23, p. 36, 1908; *The Ophthalmoscope*, Oct., 1908, p. 818) thinks that a removal of but a portion of the thickness of the sclera suffices. His procedure is as follows: After raising a flap of conjunctiva from the neighborhood of the limbus above the cornea, a medium-sized needle, curved and flattened towards its point and firmly grasped in a needle-holder, is thrust superficially into the sclera tangentially to the upper edge of the cornea, so as to become fixed in the capsule of the eyeball. A small shaving of the sclera, about ½ mm. thick, 1½ to 2 mm. broad and from 2 to 3 mm. long, is then excised by means of a narrow Graefe knife. The scleral slip is then freed from the conjunctiva at each end and the mucous membrane brought together over the wound by fine catgut sutures.

Terson believes that a filtering cicatrix is not necessary or desirable to cure an ordinary glaucoma, but approves of the procedure of Lagrange when a peripheral iridectomy has produced only a temporary effect.

Weeks has done the Lagrange operation for glaucoma many times. It has given him very good results, superior, he thinks, to the results obtained by the classical operation, in that there is filtration through the new-formed tissue at the site of the wound for a longer period of time. He does not think that permanent filtration is established in many cases, if in any. He makes the incision a little shorter than recommended by Lagrange.

Ballantyne (*The Ophthalmoscope*, July 1, 1910) has summarized Lagrange's conclusions as follows: "The results of sclerectomy vary according to the degree of hypertension of the eye operated on. Three varieties of cicatrix are distinguishable according to the amount of sclera excised: (1) That in which there is mere thinning of the sclera owing to the excised portion not reaching the posterior surface of the cornea (conjunctiva smoothly covers the cicatrix). (2) That repre-

sented by a subconjunctival fistulette, due to excision of the whole thickness of the sclera, in an eye with moderate tension (the conjunctiva lies smoothly over the cicatrix). 3. The fistulous cicatrix with an ampulliform elevation of the overlying conjunctiva, resulting from excision of the whole thickness of the sclera in an eye the seat of high tension. In cases of high tension, even a simple sclerotomy will allow ample filtration, owing to the gaping of the wound, while in cases without elevation of the tension, sclerotomy will be quite ineffectual. Lagrange therefore proposes the following rules of procedure: (a) If tension is normal to +1, do sclerectomy without iridectomy, the



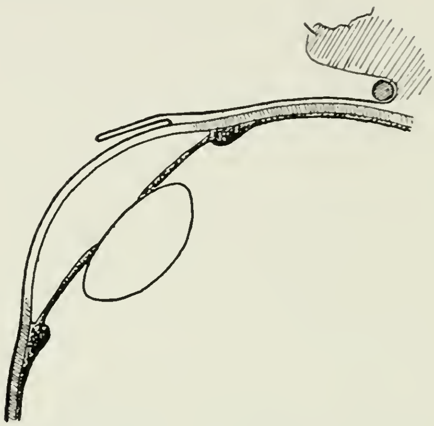
Limbal Puncture. (D. Priestley Smith.)

amount of sclera excised being inversely in proportion to the degree of hypertension. (b) If tension is + 1 to + 3, do sclerotomy-iridectomy, the iridectomy being added to avoid entanglement of the iris. Lagrange does not recommend his operation for acute glaucoma. It is especially adapted for cases of chronic simple glaucoma."

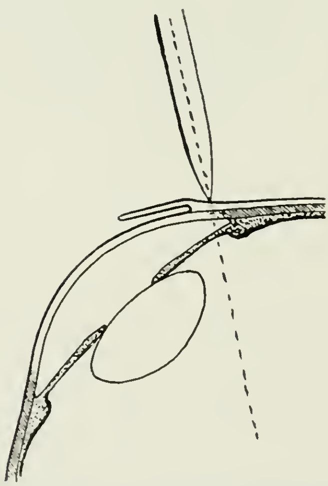
Some operators have combined sclerotomy with an irido-dialysis. Thus Knies (*Bericht der Ophthalm. Gessel.* 1893, p. 118) expressed his opinion that the value of iridectomy was chiefly in the fact that removal prevented prolapse and adhesion. He, therefore, in dealing with glaucoma, cuts through the attached base of the iris with the knife at the time of the section of the globe, making an operative partial irido-dialysis. He calls the method "irido-sclerotomy."

[*Limbal puncture.* David Priestley Smith (*Ophthal. Review.*, p. 33, Feb., 1915) described a method of puncturing the eye deeply at the

margin of the cornea for the relief of tension. It was done many years ago by Solomon, Hancock, Pritchard, and others, but never in the way described. The author has done it three times for buphthalmos and 17 times for glaucoma in adults.



Limbal Puncture. (D. Priestley Smith.)



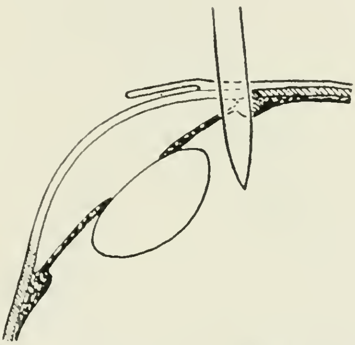
Limbal Puncture. (D. Priestley Smith.)

For buphthalmos. The puncture consists of a radial slit through the limbus, angle of anterior chamber and periphery of iris, into the vitreous. Three instruments are needed—speculum, fixation forceps, and Graefe knife.

To perform the operation: Anesthetize the child, cut the lashes, and

insert the speculum. Standing at the side to be operated on, take the forceps in the hand nearest the patient's feet, and the Graefe in the other. Seize the ocular conjunctiva 3 or 4 mm. above the corneal margin, and draw it down over the cornea until the limbus is peeled of its own conjunctiva and covered only by that stretched down from above. (See figs.) This traction also turns the eye down.

Now puncture the eye at the limbus thus: Hold the Graefe knife with its back towards the visual axis and the blade aiming for the center of the globe, i. e., perpendicular to the surface of the globe at the limbus (see fig.) and pierce the globe to a depth of about 5 mm. Withdraw the knife and release the conjunctiva, which then goes back into place and covers the wound in the limbus.

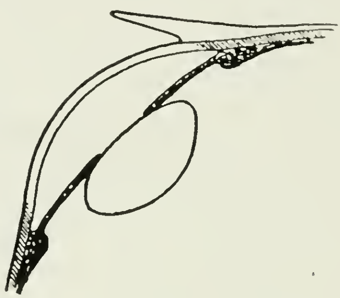


Limbal Puncture. (D. Priestley Smith.)

The above description needs amplifying: A very big cornea more than fills the lid-aperture, so that to get hold of the conjunctiva above, one has to introduce the forceps under the upper lid, for which purpose rather narrow forceps are best. When the conjunctiva is pulled down over the cornea it takes the form of a flattened tent. The line of reflection of the under layer of this "tent" from the globe can be seen as a ridge or step in the overlying layer; and to make it show well the conjunctiva must be closely applied to the globe as shown in the figure, not pulled away as in another figure. The position of the limbus has to be judged; through the thin conjunctiva of a buphthalmos it shows as a difference in color from the sclera, though not so clearly as shown in the first illustration herewith. The surgeon stands at the side of the head, facing square across the patient, so that by bending down nearly to the level of the eye when about to puncture he can make sure that the knife is perpendicular to the surface and therefore pointing to the center of the globe. A high table makes this

easier. While bending down thus he can, by slightly raising the forceps from the surface of the cornea and looking into the sulcus of reflected conjunctiva, make sure also that he does not button-hole it with the point of the knife. The knife should enter the eye until the parallel part of the blade is in the wall.

For glaucoma in adults. The procedure in adults differs in one vital point from that in buphthalmos, namely, the direction of the knife necessary to avoid the lens. The back of the knife must be parallel to the visual axis, as shown. As in a few persons over 50 the lens reaches a diameter of 10 mm. but not more, the rule should be that if the clear cornea is less than 11 mm. across in the meridian in which the puncture



Limbal Puncture. (D. Priestley Smith.)

is to be made (usually the vertical), the knife must be entered outside the limbus—always being kept parallel to the visual axis.

Except in cases where the periphery of the iris is adherent to the back of the cornea the knife thus directed can always open the anterior chamber without touching the lens, for the chamber is always wider than the lens.

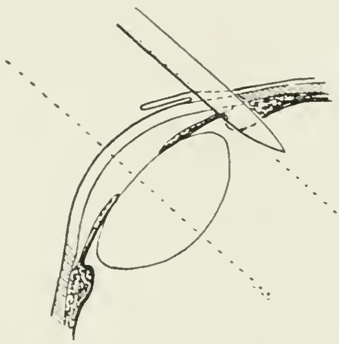
In many cases there is a trickle of blood down the anterior surface of the iris showing that the anterior chamber has been opened.

Smith believes from such a limited experience one can form only a very uncertain opinion; (1) that it may prove suitable for buphthalmos, (2) that if there are cases in adults in which it is desirable to make a radial slit through the structures, forming the filtration-angle it can be done with impunity.—Ed.]

Ciliarotomy. Within the past few years, Abadie (*Archiv. d'ophtalm.*, May, 1910, p. 262) under the supposition that irritation of the rich circular nervous plexus which covers the ciliary zone immediately behind the insertion of the iris, may induce glaucoma, has undertaken to relieve the condition by division of the ciliary zone, or, as

he terms it, by "ciliarotomy." The technique of the operation is as follows:

A fold of the bulbar conjunctiva is raised by means of forceps towards the supero-external quarter of the cornea. The conjunctiva, raised with fine dull-pointed scissors, is divided in the direction of the corresponding meridian of the eye for about 1½ centimeters. The conjunctiva being thus cleft, one takes the superior flap and with ordinary strabismus scissors detaches it from the sclera while raising it up, taking care, in order to disengage it well, to liberate its attachment to the sclero-corneal limbus by small cuts of the scissors. The inferior flap is treated in a similar way. By these means a large triangular surface of the sclera is bared, the base of which is formed



Limbal Puncture. (D. Priestley Smith.)

by the cornea and the apex by the terminal point of the conjunctival opening made in the first instance. A couple of sutures are now passed through the two conjunctival flaps, whereby they may be brought together in order to cover the wound which is about to be made in the ciliary region.

The sutures once in place, both are pulled outward in such a way as to expose the field of operation. Then, seizing with fixation forceps the conjunctiva and the episcleral tissue at the level of the inferior conjunctival flap, so as to keep the eye perfectly steady, the point of Richter's triangular knife is inserted just at the junction of sclerotic and cornea, immediately behind the insertion of the iris. It is gently plunged, so to speak, into the globe, its point being directed towards the centre of the eye, while the blade makes the incision. In consequence of its triangular form, its propulsion towards the centre of the eye causes its cutting edge to divide the ciliary zone. By slight sawing movements of the blade, this section is enlarged in such a way

that it attains a length of from 7 mm. to 8 mm.—that is to say—about the extent of the ciliary nervous plexus. The knife is then withdrawn. Contrary to what might be expected, only one or two drops of vitreous issue from the incision, which is only a mere slit.

Then, by tying the two sutures previously placed in the conjunctival flaps, the conjunctiva is brought together, thereby covering the scleral surface and the incision that has just been made.

Abadie asserts that his procedure is especially adapted to cases of glaucoma which persist despite iridectomy. The results have been uncomplicated, without luxation of the lens, or intraocular hemorrhage.

Incarceration methods.—While the operators who designed the procedures which have just been described aimed at establishing a permeable cicatrix by a filtration scar which was free from iris tissue, others have attempted to accomplish the same result by producing incarceration of the iris. As aptly summarized by Ballantyne (*The Ophthalmoscope,* July 1st, 1910, p. 510):

"The authors of the incarceration operations base their proposals on the following three facts: (1) That in such an operation as extraction of cataract the entanglement of iris in the wound frequently leads to the formation of a cystoid, or, at least, a fistulous, scar, and that the eye in consequence remains permanently soft, with evidence of leakage of aqueous fluid into the subconjunctival tissue; (2) that in iridectomies done for acute glaucoma the best and most permanent results are found in cases where the iris has become entangled between the lips of the wound; and (3) that the risk of infection of a prolapsed or incarcerated iris is greatly less in the cases where the latter is covered with conjunctiva. If the beneficial effect of iridectomy in many cases is due, not to the iridectomy, but to an accidental inclusion of iris, why not, they ask, set out to produce such an inclusion in a regulated and deliberate manner, adding the conjunctival covering to avoid risk of infection?"

Two chief advocates of the incarceration method are Herbert and Holth. In a recent communication Herbert (*Trans. Ophthalm. Soc. U. K.,* 1903, p. 324) gave the details of a variety of methods which he had employed to obtain a permeable scar by producing a large prolapse of the iris by a free sclerotomy. Finding that the iris dammed up the fluids, he was led to excise a small portion of this membrane, thereby establishing a fistula. In other cases a large conjunctival flap was made above the section and a fold of conjunctiva tucked between the lips of the scleral wound. As soon as the anterior chamber reformed, the fold of conjunctiva was distended by the aqueous and a bulging prominence formed above the wound. In favorable cases

this wound did not heal firmly and a subconjunctival fistula formed which permitted the free escape of aqueous. Another procedure consisted in fastening the fold of conjunctiva to the wound by tying the two threads of a suture into a knot, and then passing it through the middle of the conjunctival flap; the needle is then passed into the anterior chamber and the suture brought out through the upper limbus of the cornea, the two ends of the thread being tied on the surface. The thread is removed after 24 hours.

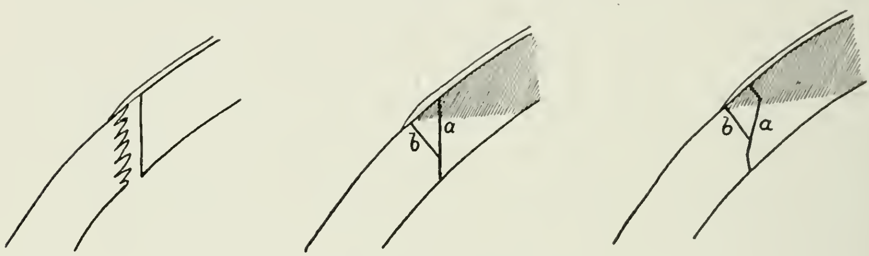
Herbert's Glaucoma Knife for the Wedge-Isolation Operation.

Wedge-isolation operation.—Herbert has devised another operation (*The Ophthalmoscope*, June, 1907, p. 292), which has been termed the wedge isolation operation. By this procedure Herbert claims to avoid what he considers the faults of the Lagrange operation, i. e., too long an incision, the excision of too large a portion of iris, and the lack of means of regulating the size and depth of the portion of excised sclera. He reports that 38 such wedge-isolation operations have been performed with uniform and trustworthy results in the production of a filtering scar. It is claimed that the smallness of the incision makes the operation a safe one, while if the procedure fail, subsequent operations of a different nature are not interfered with. The writer describes the operation as follows:

Herbert's Trowel-Shanked Glaucoma Knife for Lateral Incision in the Wedge-Isolation Operation.

The knife used (see figure) is an old and worn Graefe, ground down to a breadth of about 4/5 mm. It must taper gradually to the point. One blade which served us very well tapered from point to heel. It measured about 1¼ mm. in width at the heel and was 26 mm. long. The eye is fixed with forceps at the inner side. After the counterpuncture has been made, there is little or no trouble in the matter of fixation during the slow section, because with so small an incision the knife lying in the wound suffices almost to prevent upward rotation of the globe. The conjunctival puncture is made 1½ mm. or 2 mm. above the projected line of incision, the loose conjunctiva being then pushed down in a fold with the point of the

knife. In making the sclero-corneal puncture quite close to the cornea, the direction of the blade is nearly transverse. It must point but little downwards, since otherwise a fair share of the section is not accomplished in the puncture. Our very small primary incision is largely accomplished in the acts of puncture and counter-puncture, and if too much tissue is left to be cut in the counter-puncture, the latter can not be made without the use of an objectionable degree of force. The cutting edge of the knife is directed either exactly upwards or slightly backwards, although this latter inclination makes the counter-puncture a little less easy. The course of the blade within



A B C

The Wedge-Isolation Operation.

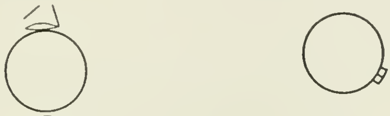
B and C Show the Directions of the Incisions Correctly, but the Position of A should probably be more to the right, in order to make the diagrams applicable to the middle of the transverse wound. Possibly there the apex of the wedge reaches the posterior surface of the cornea.

the anterior chamber need not extend to more than 3 mm. or 4 mm. The point is then brought a little forward to engage in the posterior surface of the cornea. It should reach the scleral surface quite close to the corneal boundary. As it slowly emerges, some aqueous usually leaks out beside it, raising the neighboring conjunctiva before the latter is fully pierced. As soon as the point is well through, the blade is turned to direct the cutting edge downward, and the puncture and counter-puncture are enlarged thus.

This downward enlargement is commonly sufficient when almost the whole width of the blade can be seen through the cornea, the knife being momentarily twisted to show this. It is needed to allow the blade to be twisted freely and placed correctly for the forward cut (b). But before this secondary forward cut is made, the primary incision may be further enlarged upwards and somewhat backwards, taking care to leave a bridge of superficial sclerotic still undivided. (See the figure.)

The blade is then twisted, and the secondary incision (b) forward and upward, exactly perpendicular to the surface, is made with slow, gentle, to-and-fro movements. The knife-edge should aim to reach

the surface almost exactly at the corneal margin, about the middle of the small incision. With ordinary care, gentleness and deliberation, there is no difficulty in completing this forward sclero-corneal cut without dividing the overlying conjunctiva, even though the latter be not elevated at all by aqueous. The primary upward incision is then completed subconjunctivally to isolate the wedge. The latter should be quite narrow. Its vertical measurement should be ½—2/3 mm. In completing the section, therefore, the knife-edge has usually to be turned more or less forward, as in the figure. It is obvious that precision and care are needed in locating and directing these cuts correctly, especially the forward cut (b), since quite small variations may influence the depth of the wedge very considerably. (See figure.)



D

The Two Upper Lines in Fig. D Represent the Conjunctival Incisions nearly Completing a Conjunctival flap.

It is easy, by twisting the blade a little when making the counterpuncture, to produce a free escape of aqueous beneath the conjunctiva, thus insuring it against the possibility of accidental section. But, if this be done, one can not see well enough through the distended mucous membrane for the exact outlining of the sclero-corneal strip of tissue.

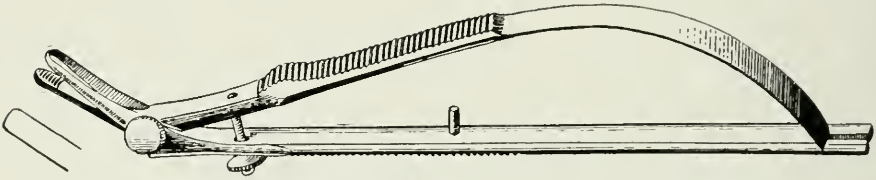
It still remains to cut a conjunctival flap, for a sufficient opening is required for the performance of an iridectomy, and it appears advisable to arrange for elastic shrinkage and subsequent distension and elevation of the conjunctiva over the wound. It is preferable to leave a small bridge of conjunctiva undivided above, to exclude the possibility of the flap becoming bent downwards over the cornea, as happened in one "jagged incision" operation upon an acutely glaucomatous eye, where the conjunctiva was somewhat swollen.

The iridectomy is, where possible, merely a small peripheral buttonhole, made solely for the purpose of preventing adhesion or incarceration of iris in the wound. For the proper performance of this minute iridectomy, and to aid in the subsequent retraction of the iris, the pupil should be always contracted, if possible, by eserine beforehand.

It may be broadly stated that the scheme and purpose of this operation are much the same as in Lagrange's sclerotomy. In the

latter operation, by excision with scissors, a groove is left in the sclerotic of somewhat uncertain depth. In the plan commonly followed, the sclero-corneal gap remains covered in by the detached strip of tissue, and, being cut from within, should bear a more definite and constant relation (as yet undertermined) to the deep surface of the cornea. The dependence upon absorption of tissue—a process of nature—in the final adjustment of the result appears sound. At least, it was thus that we came to explain the consistent results obtained formerly as regards tension, in our operations by subconjunctival prolapse of iris.

We commonly bandage the eye for a day only, and afterwards protect it with a shield. If there is any tendency to the formation of synechiæ, as there frequently is after operation for acute or sub-acute glaucoma, atropin is used freely. The tension of the eye should be



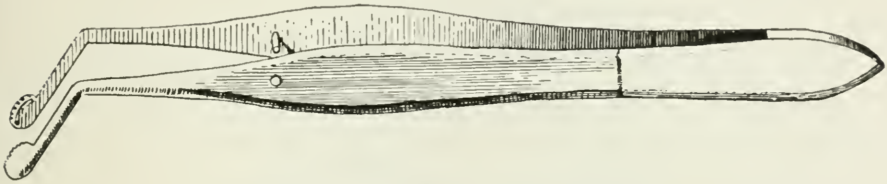
Vacher's Punch-forceps Modified by Holth for Sclerectomy.

watched for some time. In one or two highly congested eyes massage was needed the day after operation to reduce a return of tension, evidently due to glueing together of the wound surfaces by lymph and blood-clot. In a number of eyes the tension remained very low, —2 or —3, for a variable period after operation. The longest period yet observed of this low tension was one of from three to four weeks.

Holth's formation of a cystoid cicatrix. To lessen the dangers of infection and sympathetic disturbance, following the purposive formation of a cystoid cicatrix, Holth (*Ann. d' Oculist.*, May, 1907, p. 345) devised an operation which he designated iridencleisis antiglaucomatosa, and by means of which he aimed at producing subconjunctival incarceration of iris tissue combined with extrasphincteric iridectomy. The incision is usually made above with a keratome, about 10 mm. behind the corneal limbus, beneath the conjunctiva, the knife being brought out at the corneal scleral margin. The anterior chamber is now opened and a convex fold of iris brought into the wound, establishing a fistulous opening between the anterior chamber and the exterior which is covered by a broad fold of conjunctiva. (See figure.) The anterior chamber may remain unrestored for

several months after this procedure, but tension keeps normal. Schiötz advocates this procedure, but makes a normal iridectomy with a large conjunctival flap, obtaining incarceration of a small portion of the iris. He was able to secure a filtering scar in only about 28 per cent. of the cases, although Holth claimed that he secured this type of scar in 75 to 85 per cent. Vollert (*Ophthalmic Year Book*, 1908, p. 192) thinks Holth's is the best operation for the relief of glaucoma. To avoid the danger of infection through the cystoid scar, he recommends, however, the transplantation of a flap of conjunctiva after Kuhnt's method.

[*Iridotasis.*—Borthen (*Archives of Ophthalmology*, July, 1911), claims that his experience with the Holth operation and a tongue-shaped iris flap has been favorable. Of twenty-six cases, nine were



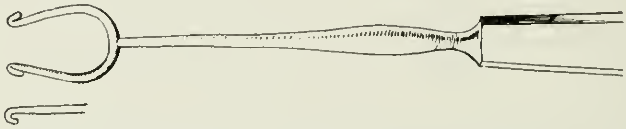
Holth's Elbowed Fixation Forceps.

It is a useful instrument for fixation of the lower part of the limbus when the eye must be turned downwards far enough to make the subconjunctival incision above with the keratome.

cured, nine unimproved, and eight could not be followed up. He has always doubted the advisability of incising the iris and making a flap for incarceration, believing this part of the operation to be unnecessary, and is convinced that the same effect could be produced by inclusion of a fold of the iris, allowing its posterior surface to coalesce with the subconjunctival tissues, assuring a position of the sphincter external to the section, and with this free drainage. The writer states that he has operated in the manner described on fifty cases and has not seen a single instance of simple or absolute glaucoma in which it failed. He proposes the term *iridotasis* for the operation. A comparison of this series with the twenty-six operated on according to Holth has convinced him that his simplified procedure is the better, and that the incision of the iris, which was supposed to be of such importance for the formation of a permanent fistula, has, on the contrary, the effect of diminishing the prospects of permanently reducing tension. Furthermore, he says, it is worth noting that iridotasis may be ineffectual where the iris is atrophic, even if subconjunctival edema appears after the prolapse. In conclusion he lays stress on the importance of operating under atropin mydriasis so that complete

paralysis of the iris may prevent spontaneous reposition, and on the advisability of avoiding forcible traction on the iris after it has been brought out through the scleral section in very old patients with a rigid iris.—Ed.]

Maher (*Ophthalmic Review*, July, 1909, p. 185), while advocating iridectomy in the early stage of chronic glaucoma, believes this operation to be useless in cases of long standing, where it is no longer



Holth's Double Blunt Hook for Turning Back the Conjunctiva after Subconjunctival Incision with a Keratome.

possible to reopen the filtration angle by this method. He believes that an operation should then be preferred which establishes a cystoid cicatrix, and has introduced a method which he claims has given him excellent results during recent years. His method of procedure is as follows:

"Having made the usual scleral section with a broad keratome, I drag on the iris with one or, preferably, two iris forceps—one in each

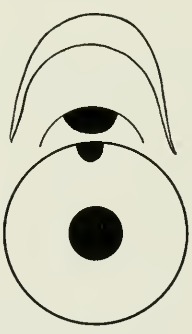
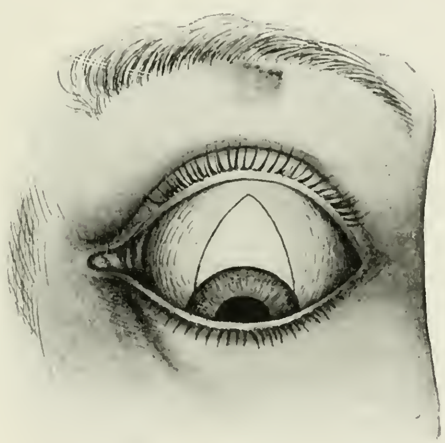


Diagram of Sclerectomy (by Holth's method) of the Anterior Lip with a Punch-forceps after Incision with a Narrow von Graefe Knife.

hand—detaching its base at the part corresponding to the scleral section. The loop of iris thus formed is left well prolapsed for a week, when it is snipped off with an iris scissors level with the sclerotic at each angle of the wound. Sometimes I vary the procedure by cutting the iris at the time of the operation at one angle of the wound, and then, by dragging on it with the iris forceps, tear it away from its attachment corresponding to the section, in the hope, if possible, of

re-establishing the communication between the anterior chamber and the canal of Schlemm. Instead of now completing the iridectomy, I leave prolapsed, at the other angle of the wound, a large portion of the tag or iris thus formed, and at the end of a week, snip it off level with the sclerotic. By this means I generally obtain small flat cystoid cicatrices. The same result may often be obtained, but with less certainty, by performing an iridectomy in the usual way, but cutting the iris so that it is left slightly entangled at one, or both, angles of the section.''

He admits that eyes with cystoid cicatrices run a risk of infection and that the entanglement of iris no doubt increases the liability to



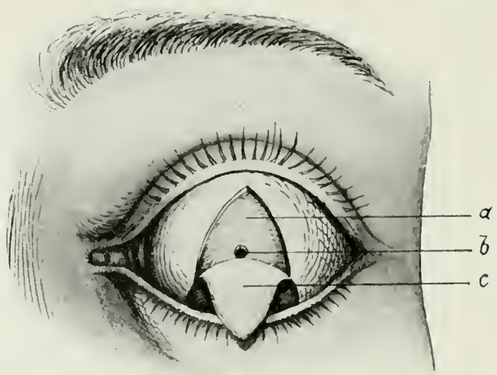
Elliot's Operation. First Stage of Operation. Showing the Site of the Triangular Flap When Made Above the Cornea.

sympathetic ophthalmia. These sequelæ, however, he has but rarely met with.

The use of the scleral trephine in glaucoma.—Fergus (*The Ophthalmoscope*, Feb., 1910, p. 74) modified the Lagrange operation by removing the piece of sclera with a trephine instead of with scissors and forceps, combining, as it were, trephining with cyclodialysis. The technique consists in dissecting a conjunctival flap up towards the cornea and laying it over the corneal surface, when a small disc of sclera is removed by a Bowman's trephine one or two millimeters from the apparent corneal margin. A repositor is then passed between the sclera and the ciliary body and iris into the anterior chamber, keeping it in close contact with the sclera and cornea. The conjunctiva is then stretched in position.

Elliot's operation for glaucoma.—Elliot (*The Ophthalmoscope*, Dec. 1st, 1909) has adopted much the same procedure and has operated on a large series of cases without septic accident, indicating to him that there is little risk in dissecting up the large conjunctival flap. He cautions against the danger of making the trephine hole too far out and thus tapping the supra-choroidal space instead of the anterior chamber. If this happens, the anterior chamber does not empty, the tension is not well lowered, and, if any effort is made to excise the bulging uveal coat, vitreous loss will occur. (See figures.) Iridectomy is resorted to if there be a tendency to incarceration.

To quote the author's own description (*The Ophthalmoscope*, July 1st, 1910, p. 483):



Elliot's Operation.

Second stage of operation. (a) Raw surface left by raising the conjunctival flap. (b) Trephine hole. (c) Flap of conjunctiva turned down over the cornea.

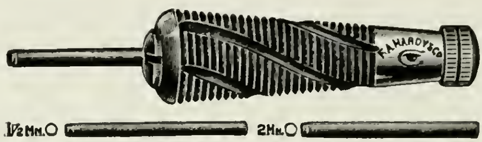
"The operation may be performed under the local influence of cocaine and adrenalin, dropped into the sac. If there is much pain or congestion, or if the patient is unruly, a hypodermic injection of morphin may be given twenty minutes before the operation. In recent cases we have been using subconjunctival injections of cocaine and adrenalin with excellent results. The patient looks down, and a large triangular flap of conjunctiva is dissected up from above the cornea, the attached base of the triangle lying at the sclero-corneal margin. Experience has shown the importance of dissecting this flap right up to the limbal attachment of the conjunctiva. The flap is turned down on the cornea. The spot selected for the trephining should be as close to the limbus as possible, and should be prepared by using the scissor points freely, either cutting or scraping or both,

right down to the scleral coat. It is important that no conjunctival tissue be left, as otherwise it will catch in the trephine and tend to draw the flap into the latter as it is working. I never pull on the flap, but simply steady the globe by pressing on the cornea through the down-turned flap; I find this quite sufficient to effect the purpose of keeping the eye at rest in the proper position. The trephine is used with quick light movements, and care is taken that its first application suffices to bite into the sclera, before it is raised to see the progress made. Once a clean ring is thus started, it is very easy to replace the trephine in it. At first the operator feels the need of frequently removing the trephine to watch progress, but he soon learns to know by the feel when he is through. As soon as the anterior chamber is tapped, aqueous fluid wells up alongside the trephine; even apart from this, there is a curious sucking sensation which tells one the trephine is through. Moreover, the patient often helps by a slight movement due to the pain (seldom severe) which attends the completion of the section. The conjunctival flap is replaced in situ to see whether the iris is in position or not. If it is, and if there is no bulging of its base into the wound, the eye is at once closed. It sometimes happens that the iris bulges into the section the moment the disc is cut through; if so, it is snipped with scissors to let the aqueous fluid escape, and it then often goes back of itself. If it does not, then an iridectomy is performed. As a rule, a very small and peripheral section of the membrane suffices; more rarely it is necessary to make the iridectomy complete. We instil eserine drops into the eye after operation, if for any reason we fear a prolapse may take place. As a rule, no drops whatever are used immediately after the operation. We have used a Bowman's trephine throughout in Madras, and are still wavering between one of 2 mm. diameter and one of 2.5 mm."

Elliot also emphasizes the following: "(1) It is possible by using the points of the scissors, and dissecting concentrically with the cornea, to get very close to the limbus. In doing so, one must keep the points directed towards the plane of the posterior pole of the lens; one must not dissect tangentially to the eye. If one does the latter, one will quickly button-hole one's flap; if the former, one undermines the limbus and makes a deep groove overhung by the latter. It is the making of this overhung groove which determines that one enters the chamber with the trephine with certainty.

(2) If the trephine used is a sharp one, one can quickly, easily and certainly cut out a clean disc every time, with the reservation that in a large number of cases the disc remains attached at one small

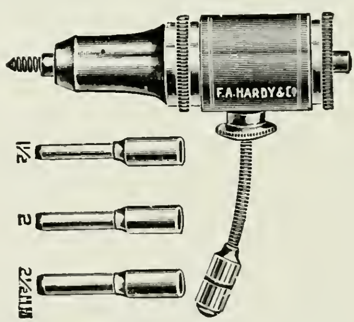
point, where the uncut tissue acts like a hinge; one clean snip of the scissors severs this, leaving a clean cut circular hole with no ragged edges whatever. I have recently made a point of pressing a little more on the corneal than on the scleral edge of the disc I am trephining, so as to make sure of entering the chamber as far forward as possible.



The Elliot Trephine.

(3) If a clean disc is thus cut out, without undue pressure of the trephine, one comparatively seldom requires to interfere much with the iris."

[The *trephine* preferred by Elliot is figured in the text. Since trephining operations came into vogue many modifications in shape and manner of employment have been described and pictured in the literature of this subject. The advantages claimed by Elliot for his instrument are, chiefly, the conical shape of the handle, which prevents slipping of the fingers during manipulations, easy adjustment of the

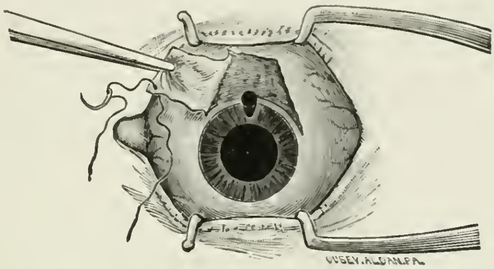


The Gradle Trephine, Driven by the Flexible Attachment.

knife and an uninterrupted view of the operative wound during the procedure.—Ed.]

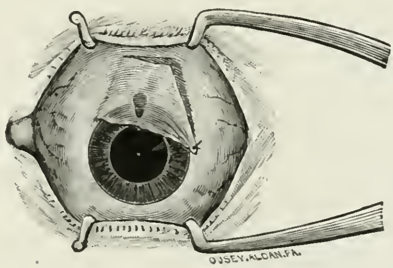
[As already stated, Elliot makes the base of his triangular flap at the sclero-corneal margin, but Fox (*Ophthalmology*, Oct., 1912) has reversed this practice, and, as in the Van Lint sliding flap operation for cataract, he seizes with the forceps the conjunctiva on the inner side of the right cornea about 4 mm. below its summit and dissects it around the upper corneal margin to the outer side, then with

scissors he detaches the conjunctiva for 12 or 14 mm. upwards. A suture is next inserted in the loosened conjunctiva at the lowest point of the inner side. From this point he makes a perpendicular incision for 14 mm. through the conjunctiva, which is continued diagonally upwards and outwards to a similar distance. (See the figures.)



Fox's Modification of the Conjunctival Flap in Trephining the Sclera for Glaucoma.

When operating on the left eye Fox begins the dissection of the flap on the outer side of the cornea and makes similar perpendicular and diagonal incisions upwards and inwards. When completed the flap is drawn over to its attached side on the eyeball, leaving a space for the trephining along the upper sclero-corneal margin. After the trephining the conjunctival flap is replaced and by means of the



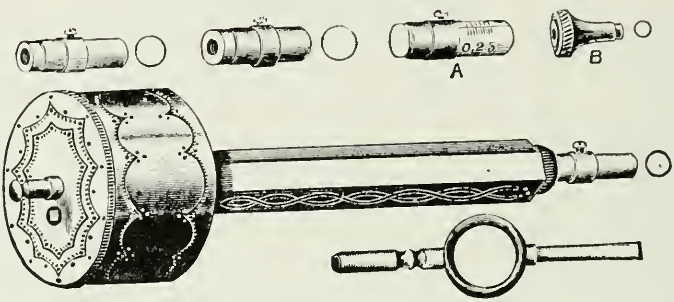
Scleral Trephining for Glaucoma. Conjunctival Flap in Position. (Fox.)

suture already inserted it is drawn downwards to cover the hole in the sclera and the upper part of the cornea.

From time to time Fox has modified the treatment of the conjunctival flap, at one time stitching it down on one side and removing the thread at the end of twenty-four hours; at another simply loosening the conjunctiva over the corneo-scleral opening and allowing it to heal—but the above-described method has given the most satisfaction.

The same operator has also modified and advised the use of the von Hippel trephine for this operation. (See the illustration.)

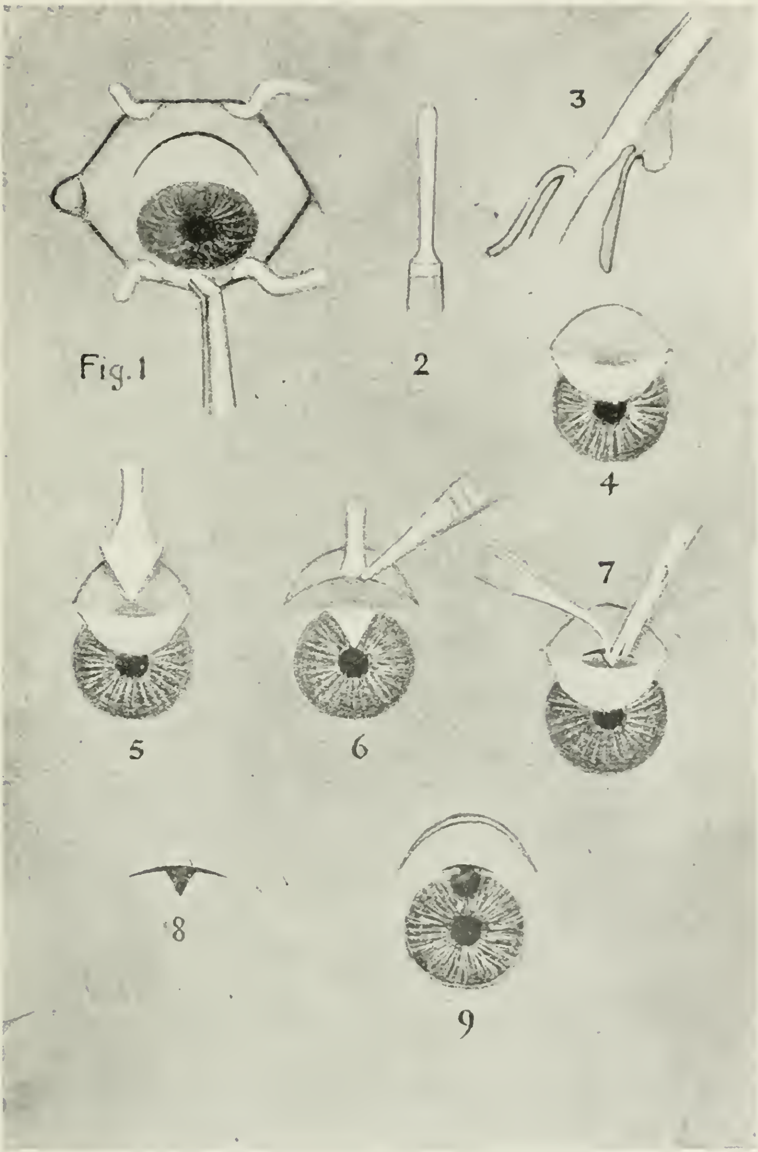
D. Priestley Smith (*Ophthal. Review*, p. 73, March, 1913) has described a modification of the Elliot or Lagrange operation as follows: It is little more than a combination of several well-known procedures, the objects being iridectomy and fistulization of the anterior chamber. It consists of Elliot's conjunctivo-corneal flap, and, instead of a trephine hole, a keratome incision notched on its anterior lip. (See the figures.) It is suggested as suitable for cases in which scleral puncture is desirable, namely, cases of high tension and shallow chamber.



Von Hippel Trephine, Adapted to Glaucoma Operations. (Fox.)

After cocainizing in chronic cases, or under a general anesthetic in acute, the speculum is inserted, and the eye turned down by an assistant. For this purpose a bent forceps is used, so that the handle shall be out of the operator's way. (See figure 1 of accompanying plate.) The operator stands behind the patient's head.

The conjunctiva is picked up 6 or 7 mm. from the cornea and incised with scissors along a curved line running almost concentric with the corneal margin, so as to leave some conjunctiva uncut between the ends of the incision and the cornea. Elliot has found that if the ends reach the cornea the aqueous may be pent in under the flap by the watertight healing of the cut edge with the episcleral tissue. The flap is dissected up with scissors until, in the middle, the corneal margin is reached. It now ceases to peel easily, and the cornea must be split. For this purpose the author made a dissector out of a broad, round-ended spatula, one edge of which he sharpened to half-way round the end but no further. (See figure 2 of plate.) If the end is sharp all the way round it is more likely to buttonhole the flap. While using this instrument the flap is kept turned down by means of small, firm, mounted swabs. If bleeding is troublesome a drop of epinine or adren-



David Priestley Smith's Glaucoma Operation.

aline on the swab is useful, as it is essential to see into the angle of reflected conjunctiva all the time. The dissection is carried on until the area of cornea exposed forms a slate-grey ellipse about 2 mm. wide in the middle. (See figures 3 and 4 of plate.)

The flap is now replaced for a few seconds, while the vitreous is tapped. This is done with a Graefe knife 6 mm. behind the cornea and just above the upper margin of the external rectus, the conjunctiva first having been picked up in forceps and slid forward so that when released it shall cover the opening in the sclera. The knife is directed towards the centre of the globe with its back to the cornea.

The flap is now picked up by forceps again and the point of a broad keratome entered immediately (less than 1 mm.) outside the margin of the cornea, the flap laid back on to the keratome, and the latter pushed into the anterior chamber until the incision is about 5 mm. long. (See figures 5 and 6 of plate.) The keratome is now withdrawn. It has been suggested, and it doubtless would be better, that the operator should take the fixation forceps while making the incision, and the assistant hold up the flap.

A small triangular piece is now snipped out of the corneal lip of the incision by two scissor-cuts converging to meet just short of the line of reflection. The aperture thus made should be about equilateral. Figure 7 of the plate was meant to represent the second scissor-cut being made, but by mistake it was drawn reversed as to right and left; the first cut should be the left, so that when the second is being made the "chip" may be steadied by iris forceps held in the left hand. Figure 8 shows the shape of gap aimed at.

The iridectomy is performed in the ordinary way. The operator tries to leave the sphincter.

The flap is now replaced, the eye released from the fixation forceps and the speculum removed. No suture is needed if the flap is above the cornea; if below it is necessary. No drops are put in unless the pupil was previously contracted by eserine or pilocarpine, in which case a drop of atropin is used. The eye is closed, a pad and shield applied and five grains of antipyrine given within the next half-hour. Figure 9 shows the ideal appearance on completion of the operation.

Late infection after trephining operations.—In doing an Elliot's trephining, the ordinary precautions seem to be sufficient to guard against infection at the time of the operation; not so, however, against a secondary infection. H. Gifford (*Ophth. Record*, January, 1914) points out that at the Heidelberg Congress in 1912, Wagenmann, in a discussion on trephining, mentioned a case in which, some time after a successful trephining, a late infection of the anterior chamber

occurred. The final outcome is not given. This remained an isolated case till June of that year (1912), since when, twelve additional cases of late infection, after Elliot's operation, have been reported. Of these, the cases of Stock, Story, Morax, Wicherkiewicz and Bronner were mentioned at the London International Congress, in the discussion of the papers of Lagrange and Elliot. Stock's two cases occurred some time after trephinings at which the flap was buttonholed. One of these led to panophthalmitis, the other to purulent iritis with much reduction of sight. In Story's case, the infection set in several weeks after the operation and led to phthisis bulbi. Bronner observed severe plastic iritis in two cases, several weeks after the operation; while in a third his patient developed panophthalmitis.

The other cases were the following: Isakowitz, severe purulent iritis six weeks after trephining; operation smooth, no reaction; no conjunctivitis nor other complication to account for infection. At time of writing the report, it looked as if the patient would not recover any sight.

Schur's patient did well for five weeks after the trephining. She then struck the eye against a chair and promptly developed a purulent iritis, and the eye was enucleated. The microscopic examination showed a line of infection beginning in a small epithelial defect a little below the trephine hole. The latter was found to be placed too far back, so that the line of infection which led to it, from the epithelial defect, proceeded into both the anterior chamber and, through the ciliary body, into the vitreous.

In Harm's case, the eye was perfectly quiet and satisfactory for about six weeks, when it began to have spells of irritation with photophobia and lachrymation, without any well-defined cause. Five months later, without any special cause, a violent infection started up with exudate and pus in the anterior chamber; much congestion; especially in the neighborhood of the filtration-bleb which, when fluorescein was used, showed a large epithelial defect. After cauterization of the bleb and paracentesis, the condition improved somewhat, but a slow iridocyclitis set in which promised, at last account, to blind the eye. An interesting feature of this case is the fact that the other eye was operated about the same time, but as the flap was perforated, the conjunctiva was loosened along the limbus and drawn down over the cornea. For some time after the operation, the filtration-bleb was as prominent in this eye as in the other, then it flattened down and disappeared. This eye showed none of the spells of irritation which bothered the other eye, in which the bleb persisted; and Harms con-

cluded that the determining factor in this infection was the irritation of the bleb by the movements of the lids and the eye-ball.

Kuhnt trephined both eyes of his patient. In the right the filtration-bleb gradually flattened down completely, while in the left the bleb remained. About three and a half months later he developed a conjunctival catarrh of both eyes; under the influence of which the conjunctiva of the bleb in the left eye became markedly loosened up. About two weeks later the eye suddenly became blind and was found to have purulent iridocyclitis, with the conjunctiva over the trephine hole grayish-yellow, thick and eroded. Under vigorous treatment with mercury, pilocarpine and Roemer's pneumococcus-serum, the inflammation gradually subsided and the vision rose to nearly what it had been before the infection. Then, the filtration-bleb gradually disappeared and the tension, which had been normal, rose to 30 mm. and the field began to contract.

Beside these infections after trephining Axenfeld and Pagenstecher report similar experiences with the iridosclerectomy of Lagrange. Axenfeld's patient maintained a hypotension with well-marked filtration-bleb for about nine months after a Lagrange operation. Then, without apparent cause, the eye got red and the bleb showed a yellowish-gray infiltrate with a minute fistula at its summit. Then a severe purulent iritis developed, which gradually yielded to treatment; but with the cure of the iritis, the bleb disappeared and the tension rose above the normal.

Pagenstecher mentioned his case at the discussion in London. The patient did well for a month after a faultless Lagrange. Then purulent iritis appeared, but it yielded to treatment.

Gifford's own experience with infection after trephining, in the thirty cases (up to 1914) in which he had done the operation, is confined to the following cases: H. O., aged 48, came to him in 1913 with the right eye blind from an injury received some years before. The left eye had vision reduced to fingers at three to four feet as the result of irido-cyclitis, with occlusion of the pupil; tension 40 mm. The right eye was eviscerated and the left eye trephined, with an iridectomy. In doing the operation he took extra pains to carry the flap as far over the cornea as possible, but did not split the cornea in the manner recommended by Elliot. No reaction followed; the tension was reduced to well within the normal limits, and the patient went home a week later. The only thing unusual about the appearance of the eye a week after the operation, was that the membrane covering the hole was unusually thin, protruding like a part of a thin bubble. He returned two weeks after the operation stating that for a couple

of days the eye had been discharging freely and had given him much pain. The writer found a marked catarrhal conjunctivitis with much congestion of the globe. There was also a slight amount of pus in the anterior chamber, and with oblique illumination, a line of purulent exudate could be traced from the trephine hole past the coloboma, behind the iris and out through the pupil into the anterior chamber. The membrane of the ball was congested and thickened, but not eroded, so far as it was possible to determine. On paracentesis, mercury and salicylates, the eye improved somewhat; the formation of pus stopped, and the inflammation decreased, but the eye remained decidedly inflamed, and the prospect for useful vision seemed very poor. Gifford was not sure whether the inflammation of the conjunctiva in this case, was primary, or whether it followed the intraocular infection. It yielded promptly to the use of zinc.

These cases make it perfectly clear that the fistulizing operations, that is, the Lagrange, the Elliot and all their various modifications which depend for their efficacy on the production of a subconjunctival fistula, carry with them the danger of late infection. Moreover, the more successful the operation from the standpoint of pressure-reduction, the greater the danger. The case of Kuhnt illustrates this most effectually. Both eyes were trephined. In the left, the conjunctival bleb persisted and the tension remained low; while in the right, the bleb gradually disappeared and the tension rose to over 30 mm. But when, later on, both eyes developed a catarrhal conjunctivitis, only the one with the bleb become infected. Axenfeld says that the cases which, after trephining, show a clear, glassy bleb always give him a feeling of anxiety. Stock, whose infections followed operations with buttonholed flaps, advises that when the flap is perforated it is better to interrupt the operation and make a fresh start. Bronner, whose experience has been especially bad (3 cases of infection), declares that, for himself, he would prefer the safer, if somewhat less effective, iridectomy. Opposed to these unfortunate results is the very significant fact that neither Lagrange nor Ellot has seen a case of late infection: and while the latter admits that the nature of much of his clinical material makes it easily possible that he might have had one without its being reported, yet Gifford thinks there is a very decided probability that his technique is in large measure responsible for his freedom from infections; and the same applies with greater force to the results of Lagrange. The latter advises to cut the flap thick, while Elliot burrows in between the layers of the cornea, in such a way, as to make the central portion of his flap extra thick. Whether time will prove it to be possible to make the flap so thick as to

entirely prevent late infections, without interfering with the efficacy of the fistula, remains to be seen. Axenfeld raises this point, and Kuhnt insists strongly that to get a good fistula we must have a thin flap. He suggests that it may be possible, by touching the bleb with tincture of opium or something of the sort, to increase its resistance to infection. The results of Lagrange and Kuhnt, however, indicate that a sufficiently thick flap to insure against infections, is not inconsistent with good pressure-regulation. As a matter of prudence, however, we might in the future, warn patients with conjunctival blebs, to pay special attention to the hygiene of the conjunctival sac and to the condition of the lachrymal passages. Patients living far from any oculist should keep a zinc collyrium on hand to combat the first symptoms of catarrhal conjunctivitis; and the importance of reporting to the oculist at regular intervals for inspection of the bleb with the aid of fluorescein, should be urged.

Of course, the fact that late infection sometimes occurs after fistulizing operations, is no more a warrant for discarding them than a similar late infection which sometimes occurs after a cataract expression, is for a return to the practice of couching, since many cases of glaucoma can be cured by these operations which are otherwise incurable; but it certainly raises the question, whether their use is justifiable in all forms of glaucoma, especially in acute glaucoma, where a single iridectomy usually gives such good results; and if the event proves that such late infections are at all common, even with the most approved methods of forming the flap, it may be doubtful whether they should be resorted to until an iridectomy has first been tried. With the exception of the single infection reported, Gifford's experience with trephining has been most satisfactory, although he does not consider it as easy an operation as an iridectomy, in chronic glaucoma. There can be no doubt, however, that there is less chance of doing harm with it than there is with an iridectomy, where the tension is at all high.

A report of Meller's (*Zeitschr. f. Augenheilk.*, Nov., 1913) shows that out of 389 sclerectomies according to Lagrange, 1.3 per cent. of the eyes were lost by late infection, while with 178 Elliot operations, late infection apparently was not observed.

In the discussion of Meller's paper, Elschnig reported an additional case of late infection after trephining, and predicted that in a few years fistulizing operations would be given up in favor of iridectomy and cyclodialysis. Gifford also noted the cases reported by Fehr, in which a case of infection from latent dacryocystitis occurred ten days after trephining. In an address delivered at the recent Clinical Congress

in Chicago, Gifford predicted that it would not be long before cases of sympathetic ophthalmia would be reported after trephining, and Casey Wood sends word that Spalding, of Portland, had already written him of having seen such a case, together with one other of late uveitis after trephining.

[Elliot (*Ophthalmoscope*, Vol. II, p. 523, 1913) contends that the operation of sclero-corneal trephining is at once the easiest, the safest and the most certain method of effecting a decompression of a high-tension eye. In his experience sclero-corneal trephining is the operation of choice, not only for cases of chronic glaucoma, but also for those of the acute condition and for the exacerbations of chronic congestive glaucoma. As to technic, he considers that the circular trephine wound is in every way justified by an appeal to scientific principles. The flap should be large, the cornea should be split for 1 mm. beyond the limbus, the hinge left at the completion of trephining should be on the scleral side of the wound, the corneal edge being cut clean through. The trephine should be planted as far forward on the cornea as possible, and a small peripheral iridectomy should invariably be performed in order to minimize the risk of iris prolapse. In doing this the disk and the protruding iris should be seized in one grip of the forceps and should be removed together with a single snip of the scissors; iris complications will be thereby avoided. He holds that the encleisis of uveal tissue in the trephine wound, whether primary or secondary, is a misfortune which we should spare no pains to avoid. The quiet iritis which follows sclerectomy of all kinds can be rendered harmless by the free use of atropin. He also believes that (*Brit. Med. Jour.*, Nov., p. 1160, 1913) some of the *causes of failure* after trephining are dislocation of the lens or vitreous body towards the trephine hole; prolapse of uveal tissue into the trephine hole, and blocking of the trephine hole by a proliferation of connective tissue, either from the episcleral tissue on the surface, or from the uveal tissue in the depth of the wound. He shows that the area of split cornea participates in the filtration. He is opposed to the sliding flap as unsound in principle; and he contends that the dissection of the flap he has advocated is within the powers of any ophthalmic surgeon of moderate skill and experience.

Elliot (*Ophthalmoscope*, Vol. II, p. 523, 1913) further points out that there are two distinct conditions under which a shallow anterior chamber persists after operation, namely, (1) cases in which the diaphragm of the eye has been displaced forward before operation, due to long-continued overstretching of the zonule, and (2) those in which a tiny fistulette is formed at some part of the periphery of the flap,

owing to a want of healing there; in such the anterior chamber cannot refill, as it is continually drained of fluid. In the former class the condition is practically incapable of much alteration, while in the latter the simple expedient of touching the neighborhood of the fistula with silver nitrate solution on a swab serves to close the channel and fill the chamber.

Wallis (*Ophthalmoscope,* Vol. II, p. 588, 1913) gives his experience of one hundred and thirty-seven cases of Elliot's operation performed in Moorfields Hospital by various members of the staff. He says that this procedure has almost entirely superceded Herbert's sclerotomy in chronic glaucoma; the conclusion has been gradually established that the tension, after the latter operation, did not remain permanently normal in the majority of cases. Iridectomy has been but rarely performed for other than acute cases; the Elliot operation has been used in not a few acute cases with satisfactory results. He considers the operation excellent but difficult, and details the technic, in most of which he follows Elliot's teaching, except that, while actually trephining he holds the flap forward so as to leave the anterior chamber open to view all the time. In the presence of an old iridectomy he thinks the coloboma area should be avoided for the trephine; and an iridectomy (preferably peripheral and triangular) should be made as a routine step in the operation. The introduction of a spatula to clear the trephine hole is unsatisfactory and dangerous; the flap should always be sutured. He finds that the anterior chamber is slowly restored in most cases in which it was shallow before the operation, and vice versa, and he suggests a preliminary sclerotomy before trephining when the anterior chamber is very shallow. The instillation of 0.25 per cent. atropin solution the morning after the operation is advocated. If a case of trephining presents a normal tension after a month, and particularly if massage does not reduce it, he thinks commencing failure is to be suspected.

Vogt (*Klin. M. f. Augenh.*, April, p. 504, 1913) trephines for all conditions of glaucoma; he has been impressed with the risks which he considers inseparable from a hand-driven trephine. These risks are enhanced if the chamber is shallow, or if, owing to a preliminary sclerotomy, the tension of the eye has been lowered; he has therefore had an electro-motor trephine made and fitted with a fixed stop, which only partly encircles the blade and so gives the surgeon a full view of the field of operation. With this instrument he finds that the operation is made much easier and safer, and that a cleaner trephine hole is cut; he lays stress on the fact that the rapid rotation of such a trephine obviates all necessity for pressure in the axis of the instru-

ment. He uses sub-conjunctival injections of adrenalin and cocain three minutes before operation, and thinks this greatly superior to the instillation of these drugs in the ordinary way.

Axenfeld's (*Klin. M. f. Augenh.*, June, p. 816, 1913) experience of trephining has been less favorable than that of many other surgeons, as he finds that in one-half of his cases the trephine opening, after a variable period, quickly has become closed by such thick tissue as to stop free filtration. He does not limit successes to those with permanently filtering cicatrices with formation of edematous areas, but thinks that many cases with closure without apparent filtration are favorably influenced. He suggests the possible occurrence of a subconjunctival microscopic filtration; also that a deeper drainage to Schlemm's canal may be opened up; and again that the iridectomy may play a part in the result. He finds "iritic irritations" rarer after Lagrange's than after Elliot's operation. When the anterior chamber is very shallow it is easier to perform an iridectomy in the course of a trephine operation than in the classical way with a keratome or knife; but he waits to know whether the final results are as good in the former cases as in the latter. He thinks that the upward movement of the pupil is the most valuable sign that the trephine is through into the chamber; the trephining should be gently continued a little beyond this point. He is much concerned over the later infections; thin blebs with a good result fill him with anxiety. Glaucoma should be healed without the formation of a fistula, if possible. He considers iridectomy, sclerotomy and cyclodialysis less hazardous methods than trephining.

Roemer's (*Trans. 37th Ophth. Congress, Heidelberg*, p. 377, 1913) operation consists of a trephining with von Hippel's instrument (3 to 4 mm.) beneath the inferior rectus, which is divided for the purpose; the anterior chamber is previously tapped, the muscle is reunited and the wound closed. He has operated on twelve cases, and was able to follow up eight; two failed, two were partial successes, and four were successes; in no case was the visual acuity or the field of vision improved; in five the vision was worse after operation; in every case prognosis had been bad before operation.

Dupuys-Dutemps (*Ann. d'Ocul.*, Vol. 149, p. 409, 1913) considers that trephining entails little surgical risk, even in acute glaucoma; he has modified Elliot's technic by detaching the conjunctiva from its corneal attachment for about one-fourth of the circumference and using this as a sliding flap to cover a 2 mm. trephine hole made just behind the limbus.

Morax (*Soc. Opht. de Paris*, March, 1913; *Ann. d'Ocul.*, Vol. 149,

p. 289, 1913) had not met with the difficulties which induced Dupuys-Dutemps to make the above modification, and feared that the sliding flap might leave the trephine hole uncovered. He found Elliot's trephining a simpler operation than a Lagrange, but considered that the verdict between the two procedures must lie with time.

Kuhnt (*Zeit. f. Augenh.*, Vol. xxx, p. 399, 1913) found a difficulty in knowing when the trephine was through; he felt himself between the dangers of insufficiently dividing the sclera, and of damaging the ciliary body; he therefore devised a trephine the tubular blade of which carries a solid style, the end of which can be adjusted to any desired depth from the cutting edge. He places this guard at a distance corresponding with the thickness of the sclera and is then able to use the instrument with confidence; the stylet can easily be removed for sterilization.

T. Harrison Butler (*Ophthalmoscope,* p. 370, August, 1915) has published under the caption, "The Tragedy of Sclerostomy," an account of eight cases of late infection after various operations—Lagrange, trephining, punching and wedge-isolation. He divides these calamitous sequelæ into three classes: (1) acute cases, ending in acute uveitis and panophthalmitis necessitating removal of the eye; (2) cases of severe iridocyclitis, which destroy the sight; (3) cases of mild iritis, and local inflammation around the aperture, which recover.

After describing the eight cases he remarks that they show every kind of scar to have been affected. "In one case there was apparently firm cicatrization with no filtration; others had ectatic scars. In two a small button-hole was made at the operation. Some operators make light of button-holes; in fact, some, I believe, turn back no flaps, and so leave an open hole in every case. My experience tends to show that a button-hole constitutes an additional danger. I have always tried to obtain a thick flap of conjunctiva and have generally succeeded in doing so. A thin covering to the aperture is obviously unsafe. It may be suggested that my cases were mostly treated with the punch, and that my conclusions can not be applied to the trephine operation. I can only state that the scars obtained by the punch method are in appearance, both to the naked eye and under the microscope, almost exactly similar to those yielded by the trephine.

"I conclude that late infection is a peril which, like the sword of Damocles, hangs over every eye which possesses a filtering cicatrix of any type, however obtained."—Ed.]

[The Editor believes that notwithstanding the pronounced drawbacks urged against the two popular forms of sclerectomy—Elliot's and the Lagrange operation—the advantages they offer over

the classic operations formerly in vogue (iridectomy in particular) are so many and so valuable that a general return to the older procedures, especially in the chronic forms of glaucoma, is highly improbable. The individual operator will have to decide whether he can more easily employ the method of the French or the British surgeon; in other words, whether he can, to the best advantage of his patient, follow the technic of the Lagrange or the Elliot procedure.—Ed.]

Verhoeff's sclerostome. Verhoeff (*The Ophthalmoscope,* March, 1910, p. 188) has devised a new instrument, the sclerostome (see figure), for producing a subconjunctival fistula, hoping to obviate by its use the trauma to the tissues which he has observed after the Lagrange operation. His experience with the operation thus far has been limited to blind, painful glaucomatous eyes, but the results suffice to show that the opening made by the instrument remained patent and was effective in lowering the tension.

Transfixio iridis of Fuchs. In secondary glaucoma with protrusion of the iris due to annular posterior synechia, when iridectomy is contra-indicated on account of the friability of the tissue of the iris and the danger of hemorrhage and recurring iritis, Fuchs (*Bericht der Ophthalm. Gessel.,* 1896, p. 179) recommends the following procedure:

"After local anesthesia and the introduction of a speculum, a medium sized Graefe knife is introduced 1 to 2 mm. within the temporal limbus in the horizontal meridian of the cornea. The blade is inserted parallel with the surface of the iris and is then passed through the anterior chamber and counter-puncture made at a symmetrically opposite point. The iris being driven forward is pierced by the knife as it traverses the chamber and holes made in it both temporally and nasally. These holes remain open and the communication between the chambers being restored, the intraocular pressure becomes normal and the iris returns to its normal position. After the eye has become quiet, it is usually advisable to follow with an iridectomy, which can now be performed without difficulty on account of the lessened tension."

OPERATIONS FOR GLAUCOMA WHICH HAVE FOR THEIR OBJECT THE INDUCTION OF DRAINAGE THROUGH THE CHOROID AND PERICHOROIDAL SPACES.

Hancock (*R. L. Hosp. Rep.,* Vol. III) being of the opinion that the ciliary muscle in glaucoma is either in a state of spasm or atrophy, as a consequence of which the loss in elasticity impeded the circulation through the vessels of the choroid and thus favored increase of tension, sought to remove the obstacle to the vascular flow by dividing the ciliary muscle. With this end in view, he introduced a Beers' knife through

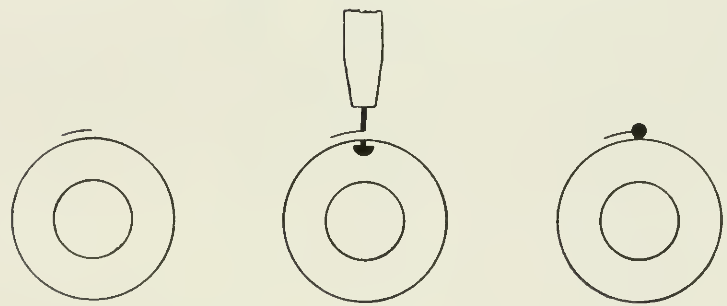
the sclero-corneal junction at the lower outer margin of the cornea, the point of the knife being directed obliquely backwards and downwards until the fibres of the sclerotic were divided for more than an eighth of an inch. Ball (*Ophthalmic Year Book,* 1908, p. 193) had good results from this procedure for the relief of pain in absolute glaucoma.

Walker's operation. Hancock's operation was modified by Walker by what was termed hyposcleral cyclotomy. In this procedure a very narrow knife is passed through the clear cornea, close to the margin, with the edge turned away from the center. It is then thrust forward through the base of the iris, care being taken to avoid injury of the lens. The knife is then slowly withdrawn, incising the sclera, which imparts to the hand the sensation of cutting through gristle. This operation differs from Hancock's sclerocyclotomy in that Hancock's is through the sclera, which is cut for about 1/8 of an inch in the danger zone, whereas, in hyposcleral cyclotomy the knife passes through cornea and iris, and the ciliary body is divided as it lies against the sclerotic.

Sclero-choriotomy. An operation somewhat similar to the foregoing is practised by Querenghi (*Annal. d'Oculist.,* June, 1900, p. 441) under the name of sclero-choriotomy, the object being to incise the eye in such a way that the ciliary muscle will be divided at its attachment to the sclera, thereby opening up a passage between the supra-choroidal space and the anterior chamber. Querenghi considered that glaucoma depends upon the lack of communication between these two spaces. The operation is performed by thrusting a needle with a lance-shaped point, or a narrow Graefe knife, through the sclera 2 mm. from the limbus into the posterior chamber. The handle of the knife is now depressed and the blade pushed forward so that it glides along the outer wall of the chamber, the cutting edge being turned toward the ciliary body. After the knife has been advanced into the chamber to the extent of 5 or 6 mm., the choroid is incised from within outwards, down to the sclerotic, by short sawing movements, care being taken not to enlarge the site of puncture, to avoid prolapse of the iris.

Cyclodialysis. Heine's operation (*Deutsch. Med. Woch.,* 1905, N. 21; *Bericht der. Ophth. Gesell.,* 1905; *Münch. Med. Woch.,* 1906, N. 2) of cyclodialysis, which bears some relationship to the foregoing, inasmuch as it is based upon the desirability of establishing a communication between the anterior chamber and the supra-choroidal space, was suggested to its originator by Fuchs' observation on detachment of the choroid in eyes after iridectomy or cataract extraction, and the hypothesis of Axenfeld that such detachment may have an important

Verhoeff's Sclerostome, Ready for Use.



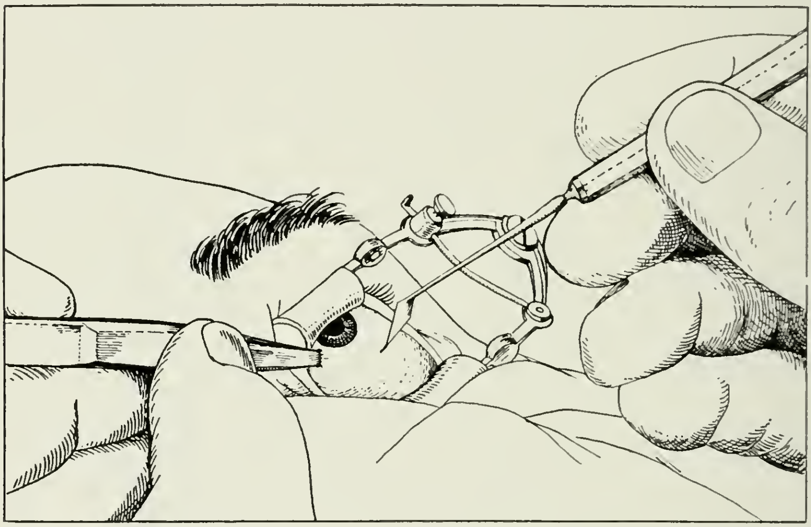
a. Position of incision. Conjunctival flap not shown.

b. Sclerostome in Position Ready to Cut.

c. Fistula Completed. Buttonhole in iris not shown.

bearing on the method of cure after successful operations for glaucoma.

After local anesthesia and the introduction of a speculum, the patient is told to look upward, and the globe being fixed with forceps, an incision is made through the conjunctiva with scissors, about 5 mm. from the limbus, in its lower and outer portion. The flaps of the conjunctival wound are somewhat undermined and the sclera exposed by causing the wound to gap by traction with two double tenacula held by an assistant. An incision 2 mm. long is now made through the



Cyclodialysis in the Left Eye. The eyelids in this operation are held apart by a spring-speculum. After the conjunctiva has been incised and the sclera exposed to view, a short incision is made with the lancet (keratome) parallel to the limbus and at a distance of about 5 mm. to the outer and lower side of it. The lancet is made to cut with its side and not with its point. (After Meller.)

sclera with a lancet or with the lateral edge of a small keratome held vertically at a distance of 5 mm. from the limbus and parallel to it (see fig.). The incision should be made with caution, to avoid injury to the sublying ciliary body, the tissues of the sclera being divided layer by layer until the black of the uvea appears in the wound. A small spatula is now introduced into the wound and pushed slowly forwards between the sclera and ciliary body, with its plane parallel to both, until the tip appears in the angle of the chamber. (See fig.) As soon as this is accomplished, the handle of the instrument is deflected to the right and left, thereby widening the incision in the angle of the chamber and detaching the ciliary muscle from the sclera to as

great an extent as possible, care being exercised to avoid injury of the lens or iris with the point of the spatula. (See fig.) The spatula is now withdrawn, the conjunctiva sutured and the eye bandaged.

Care must be exercised in making the incision to avoid injuring the anterior ciliary veins, not only on account of obscuring the field of operation, but also to obviate blood entering the chamber after the introduction of the spatula. Adrenaline will usually control any bleeding from small scleral vessels, though it may be necessary to resort to the thermocautery to stop severe hemorrhage from a ciliary vein.

The complications during the operation consist in too deep an incision, causing prolapse of vitreous. This is prevented by keeping the incision the same depth in the entire length of the wound and discontinuing it the moment the uvea appears. Instead of entering the chamber, the spatula may be pushed forward into the cornea, detaching Descemet's membrane from the substantia propria. This accident should be recognized by a sensation of resistance, when the instrument must be withdrawn and further attempts made to enter the chamber by gently raising the handle of the spatula.

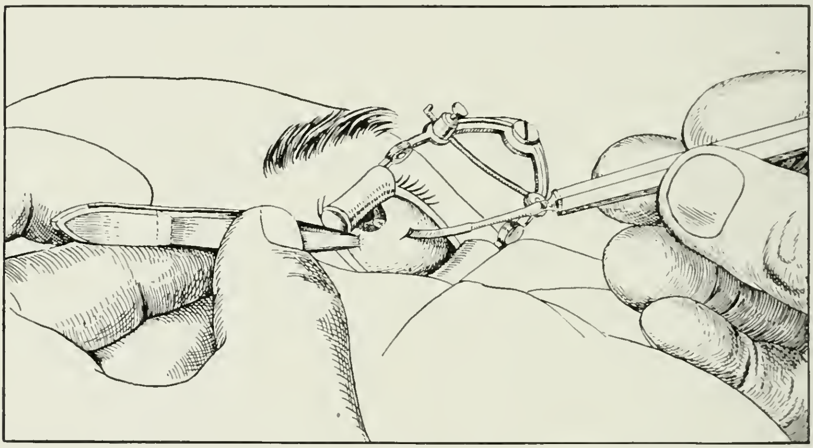
The tension as a rule after this operation does not fall for some hours afterward, and does not attain its lowest degree until one to three days later. Meller (*Ophthalmic Operations*, p. 203) has found that three kinds of cases are distinguished according to the condition of the eye after the operation: those in which (1) the tension is reduced permanently; (2) the diminution is only temporary; (3) tension is wholly unaffected. In the first class (about 30 per cent.) tension sinks gradually during the first three days; indeed it may be even subnormal. The previously hazy cornea becomes clear, the anterior chamber deeper, though still shallower than normal, the pupil a little less dilated than before. The eye may remain in this condition permanently. In about 40 per cent. the diminution of the tension is only temporary and an increase returns within a few weeks; in about 35 per cent. the operation has no effect at all on the glaucoma. This is especially the case in glaucoma absolutum.

Wernicke, drawing his deductions from 76 operations performed upon 61 patients in Uhthoff's clinic, believes that on account of the dangers of iridectomy, i. e., intraocular hemorrhage from the sudden reduction in intraocular tension, injury to the lens, and the non-closure of the wound, cyclodialysis is to be preferred to the classic operation in many cases, and is equally valuable in others. In the cases above referred to, the operation improved the condition as long as the cases were under observation (20 after a period of 2 years) in 57 per cent.,

while there was temporary improvement in 25 per cent. Only 9 per cent. showed no improvement.

Arnold Knapp reported a series of 18 cases upon which he had performed this operation, and while he did not think it could in any way replace iridectomy, he concluded that cyclodialysis is of value in certain limited conditions. He found it indicated in the advanced cases of chronic glaucoma, especially those in which iridectomy had not succeeded in reducing tension.

It seems to be the conviction of many conservative operators who have employed this procedure in a sufficient number of cases to warrant reliable deductions, that, while it may for a time lower tension,



Cyclodialysis. The spatula, held parallel with the surface of the sclera and the ciliary body, and appears in the angle of the chamber. (After Meller.)

this effect is not permanent, and the procedure, in their opinion, has not proven itself to be of equal value with iridectomy or with any other of its recent modifications.

[Meisner and Sattler (*Archiv f. Augenh.*, LXXI, p. 341, 1913) furnish the results of a series of fifty-four cyclodialysis operations, done in the years 1910 and 1911 at the Königsberg clinic. These authors regard the operation as easier of execution than iridectomy, especially when the anterior chamber is shallow. Although the ciliary body was detached by means of a flat spatula for about a third of its circumference, in only one instance was the shape of the pupil altered. In fifteen cases the operation was complicated by hemorrhage into the anterior chamber, usually from ruptured anterior ciliary vessels. In eight cases the hemorrhage was absorbed within fourteen days, and

the results were good. But the operation was unsuccessful in the other seven cases, in which absorption was slower. Accidental perforation of the uvea did not generally appear to spoil the result. Most of the patients were free from pain after the first few hours following the operation. Partial atrophy of the iris was seen in one case about a year after operation. Post-operative inflammation occurred in an old trachomatous eye, and again in a case of glaucoma following cataract extraction.

As completely successful the authors reckon only those cases in which, after at least three to six months' observation, the tension stayed normal and no deterioration occurred in vision or the visual field. These conditions were fulfilled by fifteen cases, of which five were observed for at least six months and seven for not less than a year. Two out of three of the conditions were satisfied by five further cases. Relapses occurred in ten cases, which had for a time appeared successful. As regards the relative efficiency of the operation in chronic and acute glaucoma, joint consideration of the completely and incompletely satisfactory results suggests that the prospects are most favorable in glaucoma simplex. A comparative study of results of iridectomy and of cyclodialysis done (a) each in one eye of the same patient, or (b) in the order named on one and the same eye, does not argue in favor of either mode of treatment.—Ed.]

Posterior sclerotomy. Although de Wecker is authority for the statement that Guérin practised puncture of the sclera and cornea for the relief of increased pressure within the eye as early as 1769, William Mackenzie, of Glasgow, in 1830, was probably the first British surgeon who tapped the posterior segment of the eyeball on account of increased hardness. This distinguished investigator advised scleral puncture for hydrophthalmus and glaucoma, and in some cases obtained, to use his own words, "a transient amelioration of vision as well as relief from pain," the incision being made with a lance knife at the site of the old operation for depression of cataract. The instrument was then thrust backwards towards the center of the vitreous and rotated somewhat about its axis and allowed to remain in position from one to two minutes until sufficient of the ocular fluids had escaped.

Although practised to some extent by Middlemore in 1835, the operation fell into disuse for the relief of the diseases to which Mackenzie had applied it until 1872, when de Luca (*Ann. di. Ottalm.*, 1872, II, p. 155; *Ann. di. Ottalm.*, 1876, IV, p. 217), without apparently being cognizant of Mackenzie's work, recommended it in glaucoma, not only for the relief of pain in blind eyes, but also in those which still possessed useful vision. Since that time the procedure has

been frequently practised with various modifications and is now a well recognized means of temporarily reducing tension in any form of glaucoma.

Technique. After cocainization, the lids are separated by an assistant, the patient is instructed to look upwards and inwards, and the globe is grasped near the limbus with fixation forceps. A Graefe knife is then inserted midway between the tendons of the external and inferior rectus muscles at a point at least 15 mm. behind the limbus, which seems to be free from conjunctival or episcleral vessels. The point of the knife is inserted perpendicular to the center of the globe and is permitted to enter the eye to a depth of 5 or 6 mm. If the effect of a simple paracentesis is alone desired, the knife is withdrawn and the wound permitted to close.

Cyclodialysis. Figure showing the position of the spatula during the performance of the lateral movement intended to detach the ciliary body. (After Meller.)

Usually, however, it is found desirable to augment the effect of the operation by still further incising the sclera. This is accomplished with gentle sawing movements of the knife with its edge directed forwards until a meridional incision is made, i. e., one running from behind forward, some 5 or 6 mm. in length. Care should be taken to avoid injury to the lens or ciliary body. When the incision has attained the desired length, the knife is turned slightly about its axis and the subretinal fluid, with usually a bead of vitreous, escapes under the conjunctiva, immediately made evident by a ballooning out of the conjunctiva. The knife is then withdrawn and a bandage applied. A free escape of fluid is met with, both in acute inflammatory and in chronic non-inflammatory cases. If yellow fluid presents, it indicates in all probability an earlier hemorrhage into the vitreous. External bleeding from the wound is usually but slight and can be disregarded.

Perfect asepsis will prevent the septic infiltration of the vitreous which has followed the puncture in a few instances.

Motais (*Annal. d'Ocul.*, 1887, XCVII, p. 251) has shown that, unless the capsule of Tenon is opened by the knife, but a small quantity of fluid escapes. He insists, therefore, that the incision must lie behind the insertion of the rectus muscles, and inserts the knife rather in front of the equator well away from the venæ vorticosæ, midway between the superior and external recti. A simple rotation of the knife around its axis before withdrawal will make an L- or T-shaped incision, resembling that of a leech bite, and will insure a leakage of the wound for some days afterwards; the tension will be kept down for at least two or three days. Motais follows the operation by massage of the eye for five minutes at a time every 2 or 3 hours for a fortnight or more after the puncture, as he claims by this means to retard the cicatrization of the wound and preserve its filtration without harm to the patient. If a second puncture is deemed desirable, he avoids the site of the previous incision.

Motais has found posterior sclerotomy of advantage in the following conditions: Absolute glaucoma, to relieve pain and obviate enucleation; in acute glaucoma, where iridectomy and anterior sclerotomy have not assisted the process (in one of his cases he preserved vision for nearly two years by this method); preparatory to iridectomy. He claims to be the first to call attention to the value of posterior sclerotomy, (1) in prodromal glaucoma, in which he thinks no other form of operation can take its place, (2) in chronic secondary glaucoma, (3) in acute secondary glaucoma. He thinks the action of the sclerotomy remarkable in this latter class of cases on account of its rapidity and efficacy.

Tobler (*Arch. f. Augenh.*, 1899, XXXVIII, I, p. 93), of Basel, has shown experimentally that the risk of hemorrhage is much greater if the incision is made in the equatorial plane instead of in a meridional one, for not only is the direction of most of the scleral fibers in the latter plane, and hence such sections gape the least, but with the incision in this direction only a few choroidal vessels are encountered and there is less danger of hemorrhage. Meller has demonstrated that the wound after posterior sclerotomy becomes solidly cicatrized in a few months.

T-shaped sclerotomy. When a filtering cicatrix is desired, for example, after iridectomy and anterior sclerotomy have proved of no avail, as in absolute and hemorrhagic glaucoma, Parinaud (*Arch. d'Ophtalm.*, 1885, V, p. 180) also recommended the rotation of the knife in the wound, thereby making a T-shaped incision. Claiming

that this form of incision was necessary for the persistence of filtration, he asserted that his best results were obtained in cases where there was but little escape of fluid directly after the puncture, and the tension did not begin to diminish until a day or so after the operation. He, too, thought massage useful and insisted on its continuance for a long time after the procedure.

Small equatorial sclerotomy. Masselon (*Annal. d'Oculist.,* 1888, p. 226; *Annal. d'Oculist.,* 1886, p. 231) formerly favored a long meridional incision of the sclera alone, in order to avoid injury to the deeper portion of the vitreous, and made a flat puncture and counter-puncture; later, however, he performed a very small equatorial incision.

Simi (*Bollettino d'Oculist.,* 1887, IX, p. 17) favored 4 mm. equatorial incisions through the sclera, without, however, injuring the choroid, as a precursor of iridectomy in cases of inflammatory glaucoma with obliteration of the anterior chamber.

In 1886, Galezowski (*Bulletin Mem. franc. d'Ophthalm.,* 1886, p. 256) performed what he termed sclero-choriotomy (q. v.), though in reality the procedure was a post-sclerotomy for the relief of glaucoma simplex, hydrophthalmus and profuse vitreous hemorrhages. A Graefe knife was introduced between the superior and external rectus muscles posteriorly into the sclera, choroid and retina, the incision being prolonged anteriorly to the ciliary region. Two years later he devised a peculiarly shaped knife by means of which two incisions were made through the sclera only as far posteriorly as possible. This procedure was especially applicable to cases of glaucoma simplex.

In 1894 Priestley Smith (*Trans of 8th Internat. Ophth. Cong.,* Edinburgh, Aug., 1894, p. 33) advocated puncture of the sclera as an adjunct to iridectomy in the treatment of glaucoma, and has since then written that a continued experience still confirms the value and safety of his procedure.

[*Sclerotomia cruciata multiplex.* When Wicherkiewicz (*Ophthalmology,* July, 1913) devised a new operation for certain forms of glaucoma, he was guided by the thought that whether the anterior outlets were free or irrevocably closed, they were not, in this particular procedure, the object of his operative aims. His method was intended for those forms of glaucoma in which iridectomy and anterior sclerotomy fail, viz., glaucoma simplex and those cases in which former operations had no lasting results. These are certain forms of inflammatory glaucoma in which the inflammatory symptoms are favorably influenced by iridectomy, but in which vision gradually deteriorates, then secondary glaucoma, in which the anterior outlets

cannot be approached, sets in. In other words, that part of the eye which, so far, has not received sufficient attention, viz., the sclera, ought to be made the object of treatment.

Frequently the sclera, especially of older persons, feels very rigid to the touch, and examinations of enucleated eyes confirms this by the increased thickness of the sclera. If the sclera becomes rigid, it loses its elasticity and forms a resistance in increased intraocular tension, which even in physiological fluctuations must act on the vascular, and even more on the nervous, parts of the visual organ. Then another element may play a rôle. The rigid sclera may occasionally, as will be set forth below, close the communication between the supra-choroidal and Tenon's spaces, which perhaps participates in the excretion. The vessels penetrating the sclera, especially the vorticose veins, are surrounded by lymphatic sheaths, which connect both spaces. By accumulation of connective tissue, in rigidity of the sclera, these communications are constricted or closed, which may decidedly contribute to the increase of intraocular tension. If this be the case, multiple incisions of the rigid sclera to its deepest layers must make it more expansible, lower the pressure exerted by it and prevent a stasis of lymph in the supra-choroidal space.

After instillation of cocain, a subconjunctival injection of a 1 per cent. solution of cocain with adrenalin is made into the upper, temporal region of the eyeball. While an assistant rotates the eyeball far downwards with a sharp hook, inserted above the cornea, the operator makes a long meridional incision through the conjunctiva. The subconjunctival tissue is lifted with two pairs of forceps and incised successively to the sclera, the bleeding being controlled by instillations of adrenalin. After the sclera is largely exposed, make with von Graefe knife from 4 to 6 meridional incisions, 10 to 12 mm. long, into the sclera and as many cross sections, as far back as possible. If the sclera is very thick some of the incisions are deepened, but only from 2 to 3 mm. long, as deep as the choroid. After irrigations with salt or boric acid solutions, and, finally, electragol, the wound in the conjunctiva and Tenon's capsule is closed with a few firm sutures and a bandage applied for from one to two days. The patient is not confined to bed. After from four to five days the sutures are removed. Generally the intraocular tension is considerably diminished immediately after the operation, but more so if the eye is massaged, which always ought to be done before applying the dressing.—Ed.]

The *sclera was first trephined for glaucoma* by Argyll Robertson (*Royal Lond. Hospital Reports*, Vol. VIII, p. 404), but with only partial success, and the procedure was abandoned. More recently, how-

ever, Fröhlich (*Klin. Monatsbl. f. Augenheilk.,* 1904, p. 411) recommends the removal of a piece of the sclera in preference to enucleation, or one of its substitutes, in blind glaucomatous eyes. He performs the operation as follows: Incisions in the conjunctiva 10 to 12 mm. long are made parallel to the lower edge of the external rectus to the outer edge of the inferior rectus, and the flap of conjunctiva between these incisions is turned back. Von Hippel's trephine with the 5 mm. crown is applied to the sclera back of the ciliary body, and so adjusted that a disc will be cut from the sclera without injuring the choroid. Otherwise intraocular hemorrhage would occur and render the operation unsuccessful. The vitreous breaks through the retina and choroid, lowering the tension, the conjunctival flap is sutured in place and the tension remains subnormal. In four cases reported, one irritative, one hemorrhagic, and two secondary glaucoma, the results were favorable. In a fifth case the operation was a failure.

Again this operation was practically abandoned until Elliot and Fergus modified and improved the technic, and so made a successful procedure of it.

Indications for posterior sclerotomy in glaucoma. As has just been shown, posterior sclerotomy is admirably adapted to effect a normal or almost normal depth of the anterior chamber in all forms of glaucoma, and may safely precede iridectomy when this procedure is rendered ineffective by the presence of a very shallow chamber. It may also be employed to temporarily reduce tension in inflammatory glaucoma when, for any reason, such, for example, as septic conditions of the eye, or from the immediate risk of an anesthetic, iridectomy must be postponed. The puncture holds the glaucoma in abeyance until the septic condition has been removed, or until the decrease in the inflammatory symptoms with which it is followed does away with the necessity of a general anesthetic and permits of the use of cocaine. In hydrophthalmus it is the writer's operation of choice. It is also often of service in absolute glaucoma with pain, when other operations have been of but little avail and the patient refuses enucleation. While advised and practised by some in cases of non-congestive glaucoma when the vision has been almost entirely lost, the writer believes sclerotomy is contra-indicated on account of the danger of annihilating the little vision that remains, as a consequence of the intraocular hemorrhage which may follow the procedure. The persistent use of miotics even in these desperate cases affords the best means of conserving vision.

[One of the most valuable *resumés* of operative experience by men competent to operate and observe results is that furnished by Morax

and Fourriere (*Annales d'Oculistique,* Vol. CLI, May, 1914) on the *surgical treatment of primary chronic glaucoma.* An excellent abstract of the voluminous original is given in the *Oph. Review* by W. C. Souter, and is partially incorporated herewith.

Since 1906 there have been 37 men and 40 women, as against the 9 men and 47 women of the acute series; and the ages varied from 30 to 75, with 5 cases between 30 and 40 and most between 50 and 70. Usually both eyes were affected, 64 out of 77, even when watched for only a few years.

The anesthetic was general—chloroform—only 14 times, and local—novocain 1 in 20 followed by cocaine 1 in 30 as drops, supplemented by subconjunctival injection, far back and above, of 2 or 3 drops of sterile cocaine—adrenalin if much redness—86 times, the authors much preferring local anesthesia. The operation was iridectomy in 23 eyes and sclerecto-iridectomy in 83 eyes. In the first years they stuck closely to Lagrange, using a Graefe knife, curved scissors and Vacher's punch. Since May, 1912, they followed Fergus and Elliot, using a Graefe knife to dissect into the cornea, and a 2 mm. Bowman's trephine, in most cases as far forward as possible. The iridectomy always followed the sclerectomy, and usually by the snip-drag-snip method, only in some cases was it peripheral with retention of the iris sphincter. As Elliot advises, any marked dragging on the iris was avoided. Complementary sclerectomy or sclerecto-iridectomy was done in a small number of cases that previously had had iridectomy or sclerecto-iridectomy, the site chosen being usually between "9 and 11" o'clock or between "1 and 3." The trephine was placed over the edge of the old iris coloboma. As many as three successive scleral trephine operations had been done on one eye. Sclerotomy posterior was done in cases with tension at 60-90 mm. of Hg., a fine Graefe knife being passed in radially about 1 cm. from corneal edge, and the operation gone on with after a few moments.

Of operative complications, the immediate ones were, escape of vitreous, expulsion of lens plus some vitreous, and expulsive hemorrhage, each in Lagrange cases. The post-operative ones being the early, viz., inversion of the flap after trephining, hyphema lasting 20 days, hyphema appearing on the seventeenth day, and post-operative pains, rare in Lagrange cases, 1 in 15, more frequent in trephine cases, 10 in 24; and the later, of three sorts, (a) late infection of fistulous passage, one pneumococcus infection 7 months after a Lagrange, and one 20 months after trephining; (b) late vitreous hemorrhages—2 cases, and (c) opacification of center of cornea. The anterior chamber reformed rather more slowly after trephining than after the La-

grange-Holth operation, and the authors noted in some cases that the slowness of its reforming was a good sign from the point of view of the formation of a cystoid cicatrix and of the favorable compensatory action of this scar on the tension.

Of operative results—(a) The tension and the filtering cicatrix after the sclerectomy-iridectomy, viz., (1) the state of the tension after the different interventions in chronic glaucoma. Simple iridectomy cases are few since tonometer became so general, 23 cases in all, majority showing a more or less marked return to hypertension. Of 5 cases tested by tonometer, 3 had tension greater than normal, while the other 2 had cystoid scars from iris inclusion and tension not greater than normal. Sclerectomy-iridectomy of Lagrange-Holth, 24 cases, and of Fergus and Elliot, 21 cases, fully examined. Of the 24, 22 gave tension within normal, some well below, e. g., 7, 10, 13 mm. Hg. Of the 21 cases, in 17 tension has kept normal, e. g., 14—25 mm., while in 4 cases increased tension recurred; in one of the cases the edematous flap could be felt through the lid, reminding one of a chalazion, and for many months with a tension of 44 mm. the vision held its own; (2) the evolution of the filtering scars after sclerecto-iridectomy; Lagrange-Holth, in 30 operations 20 have a marked filtering scar still after periods varying from 15 and 29 days to 2 years and 6½ years, while in 10 filtration had ceased by 1 and 2 months up to 2½ and 3 years after operation. Fergus-Elliot cases, 21 eyes have 16 fltering scars after 12 and 22 days up to 15 and 16 months; (3) filtration may soon disappear in some cases, and in others last long, but it is apparently the case that as good functional results can be got even with flat, non-cystoid scars, while an eye with a cystoid scar may develop increased tension; (b) the functional results of sclerecto-iridectomy; it is very difficult to follow up cases, and many of the cases were operated in extremis, so to say. Of the eyes operated on by the Lagrange-Holth method and watched for a year or more there are 14. All may be considered satisfactory, some are slightly worse, some slightly better, and none have gone to the bad. Of the eyes trephined and watched for a year or more there are only 6. One of these is a rebellious case calling for further treatment, while the 5 have given excellent results, but the authors say that the antiglaucomatous action of trephining is not greater than that of the Lagrange-Holth operation.

Cases with narrowed or even eccentric fields are not unsuitable for operation. Sclerecto-iridectomy is a delicate intervention, it can give rise to quite serious operative complications. The resulting subconjunctival fistula can, exceptionally no doubt, furnish the point of entry of an exogenous infection. Nevertheless in the presence of an affection

as serious as chronic glaucoma we may be thankful for having in sclerecto-iridectomy the means of arresting for a longer or shorter interval the serious disturbances resulting from increased tension.—Ed.]

PERMANENT FOREIGN-BODY DRAINS.

Seton or thread operations. In recent years several operators have devised measures by which subconjunctival drainage of the anterior chamber has been established and maintained by a silk thread. Stephen Mayou (*The Ophthalmoscope,* May, 1912) designed his operation to correct the fault common to most operations depending upon a filtration cicatrix, that of the wound healing firmly, stopping filtration through the cicatrix with resulting rise of tension.

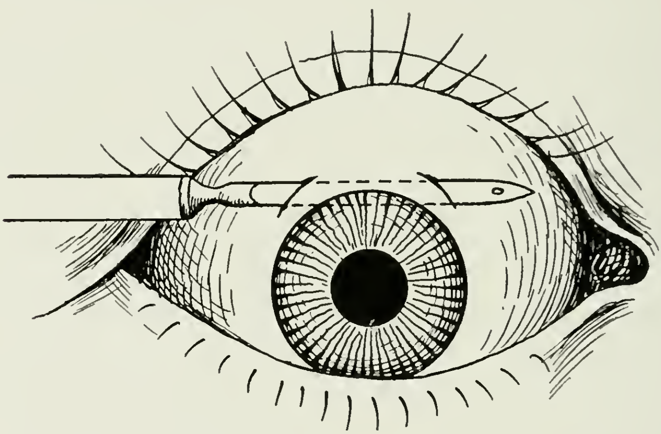
The method of procedure is as follows: After the instillation of adrenalin, cocain and eserin, a very large and thick conjunctival flap is turned forwards over the cornea and carefully dissected up to the limbus. An incision about 3 mm. long is made from the outside into the anterior chamber, by gradually cutting through the fibers of the sclerotic with the knife point, starting 2 mm. behind the limbus. A piece of black silk thread, 5 mm. long, having a knot at one end, is carefully sterilized and with a pair of forceps is laid across the incision in the sclera. With a narrow iris spatula, having a rounded notch in the end, the silk is tucked into the incision. As the silk is pushed forward into the anterior chamber, the knot sticks in the lips of the wound, whilst the free end passes forward into the angle of the anterior chamber. The conjunctival flap is then replaced in position, a stitch being inserted if necessary. The whole operation can be performed without emptying the anterior chamber, and is quite easy to execute.

The wound in the conjunctiva, after forty-eight hours, is usually firmly healed and the subconjunctival tissue is filled with fluid. At first this usually extends beyond the area of the conjunctival flap, but after a time it becomes more localized. The tension of the eye is usually subnormal from four days to a week, after which time it regains its normal tension. In none of the cases was there any iritis or undue reaction; the only contretemps was in one case, where there was a small prolapse of the iris at the time of operation. This was probably due to the fact that eserin had not been previously instilled, and that the incision was made rather larger than usual.

At the same time Arthur Zorab (*The Ophthalmoscope*, May, 1912) described an almost identical operation, which he has called *aqueoplasty:* The eye is cocainized and cleansed in the usual way, eserin being used to contract the pupil. A large flap of conjunctiva is then

raised off the globe, a crescentic attachment at the limbus being left. For choice, the flap should be taken from the upper part, which is generally covered by the lid. The whole thickness of the conjunctiva is taken, and as the limbus is neared, the conjunctiva here being thin, great care is taken not to make a "buttonhole." The flap is then reflected onto the cornea, and the globe being steadied by fixation forceps at the opposite side, an incision is made with a keratome into the anterior chamber.

The incision is about 3 mm. long, and begins about 2 mm. from the corneal margin. A small piece of sterile silk, not more than half an inch long, is doubled on itself and the bend placed against the lips of



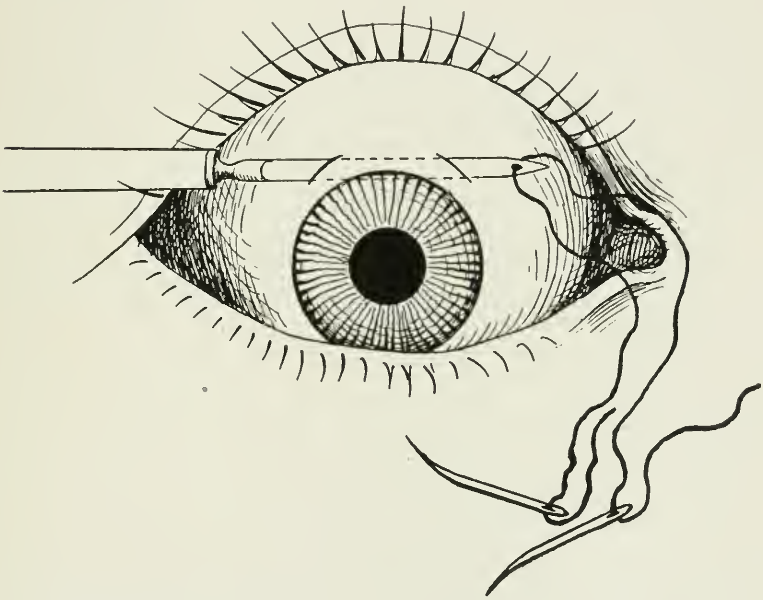
The Sclerocorneal Seton in the Treatment of Glaucoma. (Casey Wood.) Introduction of the knife as for an anterior sclerotomy.

the wound in the sclera, the rest of the silk lying on the exposed sclera. As soon as the bend can be seen in the chamber the flap of conjunctiva is replaced, thus covering the distal portions of the silk. Great care is taken at this stage to see that the ends of the silk are well away from the margin of the conjunctival flap, it sometimes being necessary to cut off a small piece from each end. The flap is then stitched in a couple of places and the operation is complete.

The eye is bandaged for a couple of days, but the patient is up and about on the day after the operation. There is very free drainage for the first few days, the chamber being abolished, and the conjunctiva rendered very edematous by the aqueous. Within a week the chamber is re-established, and the conjunctival condition improves rapidly.

Casey Wood (*Ophthalmic Record*, p. 235, May, 1915), stimulated

by the preceding efforts to establish a permanent seton-drain from the anterior chamber, as well as by the experience of Rollet (*Révue Générale d'Ophtalm.*, p. 481, Nov., 1906) and Vail (*Ophthalmic Record,* April, 1915), experimented with various forms of the intra-ocular seton in the hope of securing, if possible, by a method simpler, easier and safer than any of the foregoing, such capillary drainage of the anterior chamber as will insure a uniform and permanent outlet for the pent-up intraocular fluids—that chief desideratum in the treatment of chronic glaucoma.

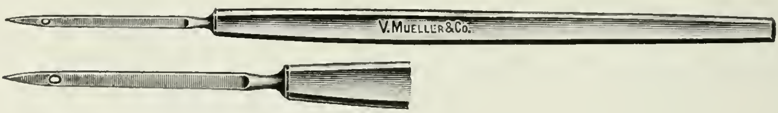


The Sclerocorneal Seton in the Treatment of Glaucoma. (Casey Wood.) Threading the knife with a double-needled suture.

After some preliminary, lower-animal experimentation, the operation was made on human subjects—seven cases in all to date. In six of these the eyes were practically blind, and would, in the ordinary course of events, be considered proper subjects for enucleation.

The procedure adopted may be described as follows: The eye is carefully rendered as aseptic as possible and the pupil is contracted by eserin. A narrow Graefe knife, with a hole near its point, is introduced and passed in precisely the same fashion as in the preliminary steps of an anterior sclerotomy. The puncture and counter-puncture are made entirely in the sclera, but as near the clear corneal margin as possible, so that at least one-half the operative wound communicates

with the anterior chamber. When the point of the instrument emerges from the globe at the counter-puncture one needle of a double-armed, white "00," braided, silk suture, about eight inches long, is passed through the hole in the knife-point. After a number of trials it was found that a half-curved needle is better adapted to the purpose than a straight one. It should be just large enough to pass easily through the eye of the knife, and should not be more than two-thirds of an inch long. Thus armed, the knife is withdrawn, so that about the same lengths of double suture protrude from puncture and counter-puncture. The knife is now freed from the sutures with scissors, and the first needles are, with a needle-holder, separately passed (by way of the counter-puncture wound) in different directions and for the length of the needle, beneath the ocular conjunctiva. The loose ends of suture corresponding to the puncture opening are then threaded and the same maneuvre is practised on that side. The so-called split- or patent-eye needle is most useful here, since a wet, sterilized suture



Knife Used in Sclerocorneal Seton Operation.

can be immediately threaded upon it; otherwise, valuable time is sure to be lost in vain attempts to pass damp thread through the eye of the ordinary needle.

It matters not what form of anesthesia be used. It is well to employ a mixture of cocain and adrenalin locally to stanch the bleeding from the scleral wounds.

The accompanying drawings will serve further to explain the steps of the operation.

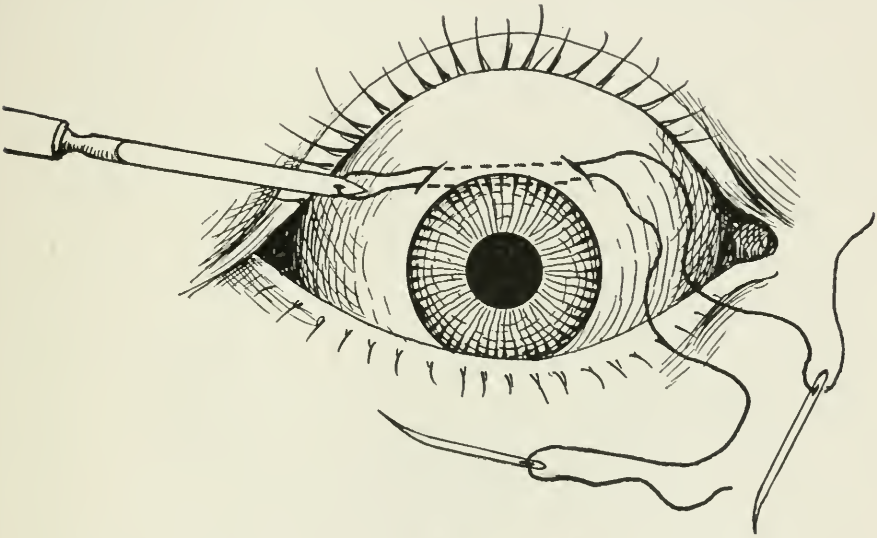
No claims are made as to the efficiency of this form of sclerocorneal seton; that, of course, will be decided by the lapse of time and future experience.

The writer believes that if the aseptic threads do not set up any more irritation and are not more dangerous than the double suture of the Zorab-Mayou procedure there may be a chance, through lining of the seton-canal with epithelium, of eventually withdrawing the threads of the seton in this operation without endangering the patency of the filtration openings. But, of course, all this remains to be seen.

Wire drain. Arthur Prince introduces (*Trans. Oph. Sec., Ill. State Med. Soc.*, May, 1915) the terminals of a *gold horseshoe-shaped wire* into the scleral opening made either in the Elliot (trephine) or La-

grange (sclerectomy) operation, for the purpose of insuring a permanent drain. The curved wire is kept in place chiefly by the overlying conjunctival flap. Prince is so far well satisfied with the results of the operation. The presence of the wire is not productive of irritation.—Ed.]

[A number of well-known surgeons have recently given their reasons for choosing some particular operative measure in certain forms of glaucoma. Of especial value are the observations of Priestley Smith (*Ophth. Rev.*, Vol. XXXII, p. 73, 1913), who divides modern opera-

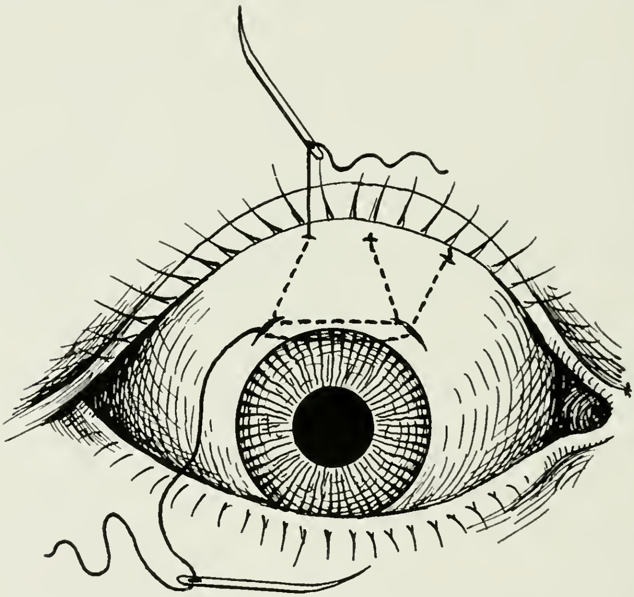


The Sclerocorneal Seton in the Treatment of Glaucoma. (Casey Wood.) Withdrawal of the knife so that the cut ends of the suture may be armed with two additional needles.

tions for glaucoma roughly into three classes, according as they act (1) by entangling iris or other tissue in the wound; (2) by complicating the form of the wound so as to prevent its closing easily, and (3) by excising a piece of tissue with scissors, punch or trephine. He is opposed to iridencleisis, in spite of the favorable results which sometimes have attended it; nor is he favorable to anterior sclerotomy or to the insertion of threads. He considers that the wedge operation of Herbert deserves more attention than it has received, probably because of the difficulty of understanding it. Lagrange's sclerecto-iridectomy has paved the way for the introduction of other methods, notably Holth's procedure. He has addressed a number of inquiries to British surgeons with a view to elicit information as to the opera-

tion they are employing, and he finds that iridectomy, though practised in a number of ways, is still the most popular operation for acute glaucoma, and trephining for chronic glaucoma.

The advantages of the trephining are summarized as (1) ease and safety of execution; (2) absence of post-operative astigmatism, and (3) thorough and permanent reduction of tension; while the disadvantages mentioned are (1) risk of losing the disk in the chamber; (2) frequent occurrence of synechiæ, and (3) persistence of subnormal tension; he is in favor of the free use of atropin after operation. In congenital glaucoma, the answers he received were very various, and



The Sclerocorneal Seton in the Treatment of Glaucoma. (Casey Wood.)
Three of the sutures in place beneath the conjunctiva.

many of them discouraging; on the other hand, some of his correspondents have spoken favorably of the treatment of this condition by iridectomy, by repeated anterior sclerotomy, by the trap-door operation, and by trephining.

He considers that the operative treatment of glaucoma has undergone more improvement during the last five years than during the previous fifty. The improvement relates chiefly to the treatment of chronic glaucoma. It has come through recognition of the fact that chronic glaucoma can be arrested only by establishing a subconjunctival fistula or filtering cicatrix in connection with the aqueous chamber. Experience will doubtless bring further change of practice, but

it is unlikely that any one method will ultimately exclude all others. On the contrary, it is likely that better knowledge of causation will lead to a discriminating choice of different methods for different forms and stages of glaucoma. The time-honored iridectomy, though now to some extent replaced by other methods, especially by trephining, is far from being obsolete. Modified in various ways, it still stands first in favor for acute glaucoma. In chronic glaucoma a permanent lowering of tension can sometimes be effected without excising any portion of the iris, but the attempt involves unnecessary risk. For every form of glaucoma the most trustworthy operation will probably always include the making of an aperture in the iris corresponding in position with the incision in the tunics.

Lagrange (*Ann. d'Ocul.*, Vol. 149, p. 213, 1913) thus formulates his conclusions: (1) Iridectomy suffices for the cure of cases of acute glaucoma, but time alone will show whether it is better to add a sclerectomy in these cases; (2) chronic glaucoma is rarely treated successfully by medical means, and demands the establishment of a fistula, and not of a filtering cicatrix; (3) the establishment of filtration is sometimes effected by iridectomy alone, but not satisfactorily so; (4) anterior sclerectomy enables us in all cases to establish subconjunctival filtration, and beyond this surgical science can not at present go; (5) anterior sclerectomy, either without an iridectomy, or with only a small peripheral one, is as efficacious as that with a complete iridectomy, and has the great advantage of permitting the patient to obtain full benefit from the use of miotics; this is proof that the excision of a piece of iris is not necessary for the cure of glaucoma; iridectomy is useful in that it serves to avoid the danger of an iris prolapse; this is, however, the limit of its usefulness; (6) the essence of sclerectomy is the establishment of a channel whereby the aqueous can pass from the anterior chamber into the subconjunctival spaces; this is effected by the removal of a piece of sclera, and is the principle underlying the Lagrange method of operating; (7) the establishment of filtration in this way is the key to the successful treatment of glaucoma, by surgical intervention, and explains the improvement in the results of modern methods as compared with those in vogue before; (8) Lagrange's method can be put into execution in many different ways, according to the skill and ingenuity of the individual operator. Of all the devices for the purpose he considers the trephine the least to be recommended, since it cuts out a circular piece of tissue; he also thinks it a dangerous instrument, so far as the ciliary body is concerned. He considers that the piece of sclera removed should be 3 to 4 mm. long by 1 mm. broad, and that it should

be taken from the neighborhood of the canal of Schlemm; he is opposed to Elliot's technic of splitting the cornea, and warns surgeons against interfering with this membrane in their sclerectomies.

Stephenson (*Med. Press and Circ.*, July 16, 1913) states that it is the view of those well qualified to judge that sclero-corneal trephining embodies better than any known procedure those points now generally believed to be essential for the cure of glaucoma, and that it bids fair to displace the other modern substitutes for iridectomy, but that like other operations it has its failures. He classifies the causes of these under the headings (1) septic, (2) hemorrhagic, and (3) mechanical. He founds his remarks primarily on a full and careful examination of four eyeballs removed after failures following this operation. In all but one of the eyes the trephine track was occluded by vascular fibronuclear tissue, through which were disseminated particles of iris pigment. In the remaining specimen the trephine track was patent, and there its closure was rendered impossible owing to the interposition of the ciliary body and lens. The anatomical features of the split cornea were also studied, and the flap was found to include some of the more superficial fibers of the substantia propria of the cornea, often a good deal altered in appearance. Most of the complications met with were due to the incarceration of uveal tissue, lens or capsule in the wound, the trephine track being obliterated by pigmented connective tissue.

Von Mende (*Klin. M. f. Augenh.*, pp. 56 and 354, Jan. 1913) says that while all recognize the simplicity of Elliot's operation and the immediate relief which it gives to tension, yet certain complications have been met with. He advocates a small basal iridectomy and the instillation of atropin; he, too, uses a sliding flap; he scrapes the epithelium from the cornea around the trephine hole in order to make the flap adhere.

Beard (*Ann. of Ophth.*, Vol. XXII, p. 363, 1913) is opposed to the making of large openings in the tunics of the eye. He prefers Elliot's operation to any other and has invented a trephine of his own for the purpose; he does not think well of cyclodialysis, nor would he use posterior sclerotomy except for blind eyes with very high tension.

Reber's (*Ophthalmoscope*, Vol. XII, p. 188, 1913) choice lies between iridectomy and one of the filtration operations. He finds Elliot's operation easy, less risky than the Lagrange operation or than iridectomy, and reasonably promising of improvement or cure. He has trephined twenty-six cases, all under local anesthesia, and is in favor of a mechanically-driven trephine; he uses a dental engine for the purpose. Intra-ocular hemorrhage will inevitably occur in a cer-

tain percentage of cases, but is a negligible factor in trephining, so far as the integrity of the eye goes. The risks under a general anesthetic are less than in iridectomy.

Verhoeff (*Ophthalmoscope,* Vol. XI, p. 220, 1913) continues to use his sclerectome (q. v.), which does not seem to have found much favor; he finds it necessary to have two instruments and to use each for not more than three consecutive cases; he is in favor of using a thin conjunctival flap, as he believes that the inclusion of episcleral tissue in the flap greatly increases the tendency of the scleral opening to close; he believes that the fluid, which escapes under the conjunctival flap, diffuses through the conjunctiva and is not removed by the lymphatic channels. Both these latter opinions are controverted by many other surgeons.

Schieck (*Zeitsch. f. Augenh.,* Vol. XXIX, p. 196, 1913) has been lately performing Elliot's operation, but in view of the short duration of his cases reserves opinion as to the ultimate result. He finds the operation a simple one. To avoid iris prolapse he makes a radial incision into the bead of iris projecting through the trephine hole, and is satisfied with the result. In one case in which he did not incise the iris, as it did not present in the wound at the time of operation, there was a return of tension, due to this membrane filling up the wound; eserin permanently relieved the condition. In another case in which the iris was adherent far forward, the trephine entered the vitreous chamber, but the case did well. He would reserve trephining for cases in which sclerotomy was formerly held to be indicated, and in others he would perform an iridectomy.

Grosz (*Amer. Jour. Ophth.,* Vol. XXX, p. 365, 1913) performs Lagrange's operation for cases of simple glaucoma. He trephines in chronic inflammatory glaucoma, does an iridectomy for all acute cases, and simple sclerotomy for juvenile glaucoma; he enucleates eyes which have passed into the degenerative stage. He still keeps an open mind as to what will be the operation of the future.

Meller (*Zeit. f. Augenh.,* Vol. XXX, p. 447, 1913) reports on 389 Lagrange and 178 Elliot operations. Of the former 12 per cent. were for acute glaucoma, 61.5 per cent. for chronic inflammatory glaucoma, 9 per cent. for the simple variety, the rest miscellaneous. In 4 per cent. no iridectomy was done: the period of observation extends to five years. There was a good result in 70 per cent. and bad in 10 per cent.; opacity of the lens followed in 4 per cent.; the formation of posterior synechiæ was very common: in 3.4 per cent. the eye had to be enucleated, in 2.3 per cent. there was severe iridocyclitis, and in 1.3 per cent. there was late infection: two eyes were lost from expulsive

hemorrhage; there was recurrence of trouble in 11.3 per cent. With regard to the Elliot operation, Meller finds that while it is less dangerous than the Lagrange, it offers the same chances for the establishment of filtration; it was followed by a bad result in only 2.4 per cent.; the performance of an iridectomy is necessary in order to avoid recurrence of high tension; he thinks that trephining is to be preferred to sclerectomy; it is not possible to claim that trephining takes the place of von Graefe's iridectomy; on the other hand, in difficult and dangerous cases it may be available in place of that operation.—Ed.]

Excision of the superior cervical ganglion. In the symposium on the relation of the cervical sympathetic to the eye, which was held in the Section on Ophthalmology of the American Medical Association in New Orleans in May, 1903, de Schweinitz, in a paper on the Physiology of the Sympathetic in Relation to the Eye, said: "As long ago as the time of Pourfour de Petit, that is, in 1727, it was observed that after section of the sympathetic, the eye was softer, and this fact was afterwards verified by Claude Bernard and other experimenters, and very early it was suggested that a primary disease of the sympathetic ganglia of the neck might be the basal cause of glaucoma."

The various theories which had been advanced by different observers to explain the influence of the sympathetic on intraocular tension were then discussed at length and the conclusions from the evidence which had been collected summarized as follows: "Electrical stimulation of the cervical sympathetic produces at first an increase and later a decrease of intraocular tension, the increase being probably due to an effect on the muscles of the eye. Slow-acting, mechanically-produced irritation of the sympathetic causes a rise of tension, which, according to Lodato, is independent of dilatation or constriction of the blood vessels, and also independent of the state of the pupil. Section of the sympathetic, or extirpation of the sympathetic ganglion, is followed by a fall of intraocular tension, which depends on vascular and, perhaps, muscular changes. The lowering of tension is more decided after excision of the ganglion than after section of the sympathetic cord, but in either case the effect is a temporary one, and may last no more than a few days, and sometimes disappears within a few hours."

According to Grimsdale and Brewerton (*Ophthalmic Operations*, p. 312), Wegner noticed changes of the intraocular pressure in animals when the cut end of the cervical sympathetic was stimulated, a fact noted in the 12th volume of Graefe's *Archives*. It was not, however, until 1897 that any form of operation was proposed on the vaso-motor nerves of the eye to influence glaucoma, when Abadie (*Arch. d'Ophtalm.*, Vol. XIX), who ascribed the increased tension of glaucoma to a vascular disturbance, proposed to relieve the condition by the re-

moval of the cervical sympathetic. Before he had an opportunity, Jonnesco (*Centralbl. f. Chirurgie,* 1899) published a paper in which he reported the results of a series of operations which had been performed in pursuance of Abadie's suggestions. Both of these investigators, however, held different theories as to the cause of glaucoma, Abadie attributing it directly to an increase of exudation brought about by an active dilatation of the blood vessels, particularly the arteries, while Jonnesco asserted that the small arteries are contracted, and that the resulting increase of intra-vascular pressure occasions an increased transudation and probably an increase in the amount of aqueous humor. The dilatation of the blood vessels was thought by Abadie to be due to the activity of the vaso-motor centers, and he asserted that, when the chain is cut, the stimuli cease, and the blood vessels resume their normal caliber.

Jonnesco removes the superior cervical ganglion by an incision along the anterior border of the sterno-mastoid muscle, about 3 inches long, having its center opposite the angle of the jaw. The various layers of the cervical fascia are then carefully divided until the border of the muscle is exposed. The sheath of the carotid artery is then laid bare and the dissection continued between the artery and vein until the ganglion is exposed behind the former.

To avoid the risk of opening the sheath, Burghard (*British Med. Jour.,* Oct., 1900) deflects it inwards with a blunt hook, when the sympathetic ganglion is found just posteriorly. The ganglion is readily freed from its surroundings by careful dissection, and is excised by a few clips of the scissors, the ascending branches being divided close above the top, and the descending cord about half an inch below the ganglion. The wound is then sutured. Some operators advise exposing the ganglion by way of the posterior portion of the sterno-cleido-mastoid muscle, but, as this exposes the spinal accessory nerve to the risk of injury, the anterior route is to be preferred.

In the symposium referred to above, Wilder spoke of the influence of resection of the cervical sympathetic ganglion in glaucoma and epitomized the records of 68 operations done on 54 cases in the following table:

Form of glaucoma.	No. of cases.	Improved.	Temporarily improved.	Stationary.	Unimproved.
Simple chronic	38	15	5	3	15
Chronic inflammatory	16	4	3	3	6
Subacute	4	3	1	..	..
Acute	3	1	1	1	..
Absolute	4	1	..	..	3
Hemorrhagic	2	2	..	..	..
Buphthalmus	1	..	..	..	1
	68	26	10	7	26

The results exhibited in this series of cases, at first glance, do not seem as favorable as those presented by Rohmer (*Annal. d'Oculist,* July, 1902, Part I), who drew conclusions from a study of 74 cases collected by Richat, to which he added 20 of his own. On these 94 cases, 114 operations were done. The following table gives a summary of the results of their analysis of these cases:

Form of glaucoma.	No. of cases operated on.	Improved.	Negative.	Worse.
Simple chronic	43	36	5	2
Chronic inflammatory	34	23	10	1
Subacute	14	6	6	2
Acute	9	4	5	..
Absolute	3	1	2	..
Hemorrhagic	5	5	..	..
Hydrophthalmus	6	4	1	1
	114	79	29	6

As a consequence of the statistics which he had gathered, Wilder thought that while positive conclusions are yet to be reached and will not be attained until more carefully selected cases can be studied for longer periods of time, he could assent to the statement of Axenfeld that "there is obtained by this operation in a certain proportion of cases of simple glaucoma, a definite and important result, and in some instances there has been a decided improvement, even where a previous iridectomy has failed."

Wilder considered the operation in itself, while a major one, is not to be regarded as one of unusual danger, and with modern technique should show a very trifling mortality. His conclusions were as follows: "The statistics up to date seem to indicate that the simple chronic form is the one most suited for it, next to the hemorrhagic form, if that can be determined. As a guide for my own practise, I should feel very much like following Abadie when he says: 'In acute forms of glaucoma and in subacute with intermissions, practise first iridectomy, and if it fails, do sympathectomy. In simple glaucoma, use miotics twice a day; if they suffice, continue them. If, in spite of their systematic employment, the vision fails, do sympathectomy.' "

During the past few years the operation has been rarely practised, for, though sometimes successful in reducing tension, disastrous results have also occurred, and several have died from the operation. In others symptoms of tachycardia and exophthalmus have developed. Its most favorable results are no better than can be attained by other and less dangerous operations on the globe itself, or from the continuous use of miotics.

Elschnig's experience (*Klin. Monatsbl. f. Augenheilk.,* May, 1912)

with sympathectomy has led him to discard the operation. He reports having done it in six cases, two of secondary glaucoma, one of secondary hydrophthalmus, two cases repeatedly operated upon by cyclodialysis and iridectomy, and a case not previously operated upon. In every case the tension became lower, but only for a time. On the other hand, the operation was followed by a disfiguring ptosis with elevation of the lower lid, while in two instances there was violent and long-continued headache, and in one tinnitus aurium. Jess reports a case in which a paresis of the left sympathetic had existed since childhood, probably due to thyroid enlargement. Nevertheless absolute glaucoma developed in the left eye, which should have been protected against glaucoma if the theories on which sympathectomy is based are correct.

Removal of the ciliary ganglion. Believing that the ciliary ganglion controls the vascularization of the anterior segment of the eye, and the superior cervical ganglion that of the posterior segment, Rohmer (*Annal. d'Oculist*, July, 1902, Part I) devised an operation for the removal of the ciliary ganglia of the orbit and practised it on seven cases of absolute glaucoma. His procedure was as follows: After a resection of the outer wall of the orbit, as recommended by Krönlein, the tissues of the orbit are exposed as directed by this operator, by dividing the periosteum and orbital fascia until the external rectus muscle is laid bare. This is divided and efforts made to remove the ciliary ganglion, which consists of a nerve mass not more than 2 mm. in its largest diameter, and lies about 15 mm. behind the posterior pole of the eye, and about 9 mm. in front of the optic foramen, between the external rectus muscle and the optic nerve, by means of a special forceps. These are a modification of the common forci-pressure forceps, one blade being grooved on its outer surface longitudinally, to permit of its being guided along the optic nerve on its outer side. Half a dozen bites of the orbital tissue are made with these forceps, a careful examination being made of the avulsed fat and tissue after each attempt, to discern the bruised and mangled ganglion. Even if the ganglion is not found, a pallor of the conjunctiva and a fall in tension indicates its removal, and the surgeon may proceed to the closure of the wound, which is accomplished as directed by Krönlein. Although Rohmer claims that the pain in the seven cases operated by him was ultimately alleviated, even though tension was never reduced to normal in any, the operation has not been practised by others; indeed, Parsons believes that the results of Rohmer's work afford little support to the view that the increased intraocular tension of glaucoma is in any way associated with the ciliary ganglion.

Terrien and Poirson have reported seven cases of absolute glaucoma

successfully operated by this method, but other operators seem to have found the procedure too drastic for cases of even absolute glaucoma, and it has not yet found a place in ophthalmic surgery.

Avulsion of the infratrochlear nerve. In 1883 Badal (*Annales d'Oculist.*, p. 84) recommended stretching of the infratrochlear branch of the nasal nerve to relieve the pain of glaucoma. It was noted that hypotonus frequently followed several weeks after this procedure, but the degree of the hypotonus was less than after iridectomy or sclerotomy, and was probably occasioned by the simultaneous avulsion of the sympathetic root of the ciliary ganglion. Abadie and Idovian (*Arch. d'Ophtalm.*, II, p. 225) operated on several cases after this method, and Angelucci on thirteen. In all cases, a temporary decrease in pain and hyperemia and intraocular tension followed, but the symptoms reappeared after several days. The procedure has been especially recommended in glaucomatous myopic eyes in which dislocation of the lens was to be feared at the time of operation, also in hemorrhagic glaucoma, and finally Villemonte (*Rec. d'Ophtalm.*, 1906, p. 513) thinks it of service in glaucoma simplex and secondary glaucoma. —(W. C. P.)

Glaucoma, Absolute. See page 40, Vol. I, of this *Encyclopedia*.

Glaucoma, Anterior. This term is applied to the disease when the chief alterations appear in the anterior ocular segment, such as adhesions of the iris to the cornea, closure of Schlemm's canal, etc.

Glaucoma apoplecticum. (G.) This form of the disease is associated with multiple hemorrhages in the retina and choroid; frequently also into the iris and vitreous. It is to be differentiated from hemorrhagic glaucoma.

Glaucoma assoluto. (It.) Absolute glaucoma.

Glaucoma, Compensated. Elschnig has proposed this term as a substitute for glaucoma simplex; also "uncompensated" for "inflammatory" glaucoma.

Glaucoma, Congenital. Sometimes regarded as synonymous with infantile glaucoma or buphthalmia. See page 1339, Vol. II of this *Encyclopedia*.

Glaucoma degenerativum. (G.) Advanced form of the disease in which sclerosis of the whole eyeball sets in, local staphylomata appear and these lesions are followed by enlargement of the globe.

Glaucoma diabeticum. (L.) Glaucoma that occurs in diabetic subjects.

Glaucoma evolutum. The second stage of glaucoma.

Glaucoma fulminans. This term is given to those rare cases of acute inflammatory glaucoma in which blindness follows quickly in the

wake of the first attack of the disease. Prodromal symptoms are often absent. There is rapid rise in intraocular tension with maximal dilation of the pupil and intense pain. Vision may be lost within a few hours. Ophthalmoscopic examination shows diffuse haziness of the aqueous and vitreous humors, with engorgement of the retinal veins and narrowing of the arteries. In a brief period, often within a week, the optic-nerve head shows an excavation. Sulzer and von Graefe observed cases in which the nerve-head was red and swollen. The disease occurs in persons over 50 years of age. The prognosis is serious. An iridectomy, if made promptly, may save useful vision.—(J. M. B.)

Glaucoma, Hemorrhagic. See **Glaucoma.** In addition to the matter therein, attention may be called to the paper of Stähli (*Archives of Ophthal.,* May, 1913) in which he declares that the changes found in the vessels of cases clinically recognised as hemorrhagic glaucoma are so characteristic as to warrant a separate classification of this disease from ordinary glaucoma. Microscopic examination of three typical cases, in which the eyes had to be removed on account of the increased intra-ocular pressure, showed changes found in the central artery as well as in the central vein. In two cases the endarteritic thickening is due to the swelling and hydropic condition of the intima cells. This edema cannot be without importance. It seems likely that acute, especially transitory conditions of occlusion of a vessel may be brought about by such changes. The central vein shows marked sclerosis. A curious change is presented by the vein in one case, namely, a division of the lumen into three parts with cessation of two. This is probably a congenital condition, which was of importance as soon as the circulation became disturbed. In all the vessels the endothelial layer is intact. This explains the absence of thromboses. The retinal vessels show in all cases more or less sclerosis. Vascular changes are also found in the choroid, iris, and ciliary body. There are no ruptures of the vessel wall.

Glaucoma hemostaticum. A name proposed by Lange (*Klin. Monatsbl. f. Augenheilk,* Nov., 1912) for that form of the disease in which lymph and blood stasis is prominent. See **Glaucoma, Malignant.**

Glaucoma, Hereditary. F. P. Calhoun (*Journ. A. M. A.,* July 4, 1914) has investigated *hereditary glaucoma simplex* and believes that, as Lawford points out, in that disease "anticipation" is a prominent feature; in other words hereditary glaucoma practically always develops in adults, or at an age far remote from the usual periods and whenever a case of glaucoma simplex is recognized in one under the age of 30, suspicion as to its possible hereditary character should

be aroused. The smallness of the cornea and globe plays an important part in the pathogenesis of the disease; it, however, is not the sole cause, for two families of myopes have been reported. Unfortunately few corneas have been measured. General diseases, other than gout and rheumatism mentioned by the older writers, have small part in the causation of this disease. Transmission by the two sexes is, roughly, equal in both. The male sex, however, shows a greater liability to inheritance. See **Heredity in relation to the eye.**

Glaucoma imminens. (G.) Glaucoma threatened but not yet fully developed.

Glaucoma, Infantile. Juvenile glaucoma. See **Buphthalmia.**

Glaucoma, Malignant. A name given to that form of the disease that is unimproved or made worse by operation or other treatment. C. F. Heerfordt (Graefe's *Archiv für Ophthalmologie*, Vol. 89, p. 62, 1914) points out that the most noteworthy of the peculiarities of malignant glaucoma, first described in 1869 by Graefe, is that the anterior chamber, instead of being re-established within a few hours after operation, is either not re-established at all or only in a slight degree. To this a second and highly characteristic peculiarity should be added: that is, the development, with gradually firmer closing of the operative wound, of a rise of tension, which, as a rule, decidedly exceeds the increase of tension which was present before the operation. Gilbert has stated that the method of operation cannot be the cause of this change for the worse, since it occurs not only after iridectomy, but also after any of the modern operations, based as they are upon most varied principles.

Referring to his own recent work on the valvular blocking of the vortex veins as a cause of glaucoma (hemostatic glaucoma), Heerfordt argues that the mode of origin of malignant glaucoma is to be explained as follows: (1) There is very close agreement between the clinical symptoms and anatomic changes of malignant and hemostatic glaucoma, since the only variation, that is, the complete obliteration of the anterior chamber which arises in malignant glaucoma, is accounted for by the fact that the hemostatic glaucomatous displacement forward of the iris, ciliary body and lens must necessarily be especially pronounced if hemostatic glaucoma occurs in an eye whose anterior chamber is opened. (2) In eyes with chronic glaucoma, at the moment when a surgical opening is made, there exists a decided tendency to the occurrence of "valvular blocking," which (according to Heerfordt's earlier work) is practically certain to produce hemostatic glaucoma. (3) Consequently malignant glaucoma is probably

occasioned by the same valvular blocking of the vortex veins which produces hemostatic glaucoma. Malignant glaucoma is thus conceived as an "exoperative hemostatic glaucoma" (glaucoma hemostaticum exoperativum). Either a valvular blocking may have existed prior to the operation, on the basis of a congenital overlapping of the sinus or of the venous channel, or a valvular block not previously existent may arise during or immediately after performance of the operation.

In the belief that the most malignant cases generally depend upon the occurrence of a venous stasis which did not previously exist, Heerfordt maintains that to avoid such an accident the essential condition is to keep the tension of the eye normal for a suitable length of time before operation. He places the length of this period at seventy-two hours. It is preferable that the pre-operative reduction in tension should be constant and complete. As means for lowering the tension he uses: (1) instillation of a 2 per cent. pilocarpin solution in the conjunctiva; (2) the introduction of solid physostigmin salicylate into the conjunctiva, in the bulk of a small pin head, 1½ hours before operation; (3) venesection, according to the method of Eversbusch and Gilbert; and (4) subconjunctival puncture of the anterior chamber with partial evacuation of the aqueous humor.

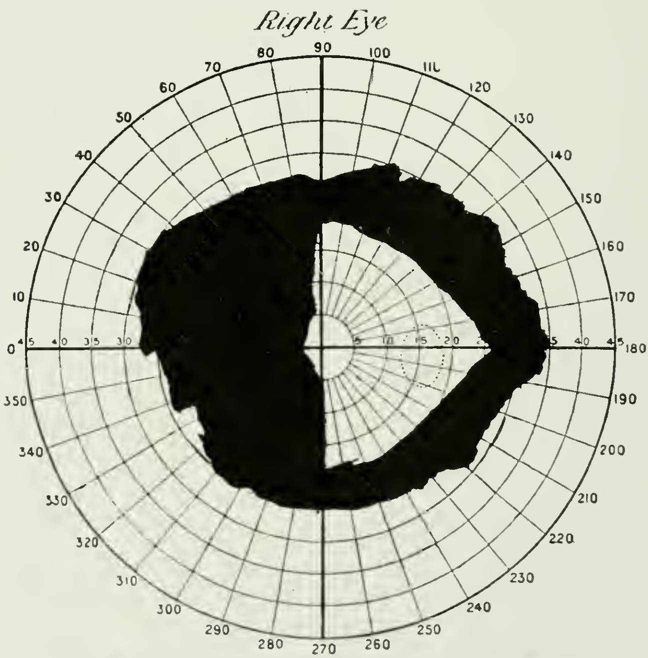
Nine illustrative cases are described in which Elliot's trephine operation was done and one or more of the prophylactic measures just referred to were employed. (Heerfordt regards Elliot's "quiet iritis" as merely the expression of a venous stasis set in action by the operation.) None of these operations was followed in any marked degree by the "malignant" symptom complex, and none of the operated eyes showed the least subsequent loss of function. All of them belonged to the type of eyes with chronic glaucoma, whose tension is influenced sluggishly, incompletely and only for a short time by pilocarpin. In the majority of the cases the glaucoma was advanced and had existed for a long time, and in most of the cases the tension was quite high. The prophylactic measures referred to are to be employed therapeutically in cases which show any post-operative tendency to a malignant character. (*Ophthal. Literature*, 1915.)

G. F. Alexander (*Ophthal. Rev.*, July, 1914) describes the case of a woman, 46 years of age, who came to him after having had the left eye removed following unsuccessful operation for glaucoma. When first seen by Alexander the right eye had a tension of +2. and the pupil was contracted by eserine. He performed iridectomy and the next day there was obliteration of the anterior chamber and tension of +3. On the day following, as there was no improvement, repression of the lens was performed. A puncture through the sclera was made

near the equator between the inferior and external recti muscles, and pressure was made on the center of the cornea with a curette, so as to push the lens directly backwards. This was accompanied by considerable loss of vitreous, and after seven minutes the lens remained back in position and the tension was subnormal. A few minutes after the performance of the sclerotomy blood appeared in the anterior chamber. The subsequent course of this case had been so far, *i. e.*, four months after operation, entirely satisfactory. The tension remained below normal and there had been no pain.

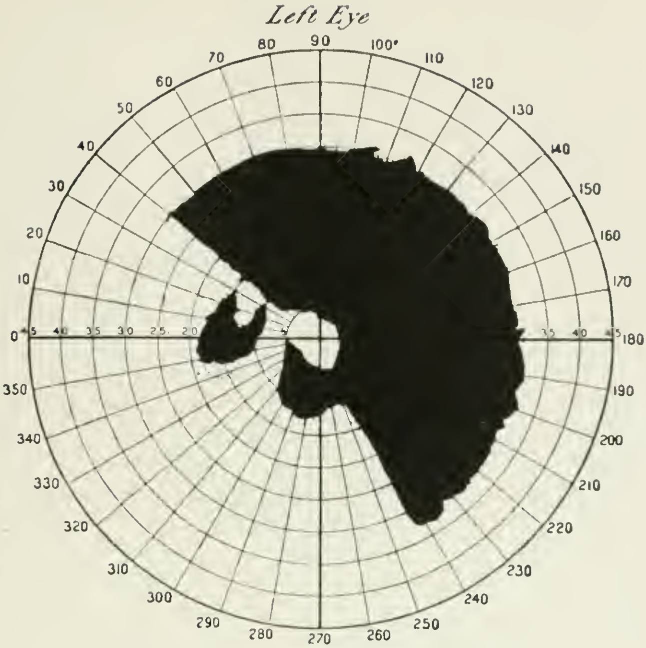
Glaucoma, Myopia in. As Burton Chance (see **Glaucoma**) says, myopic eyes are not often the subject of glaucoma. When they are affected the glaucomatous process generally runs a slow course. In other words, there appears to be some antagonism between glaucoma and myopia. Myopia may develop during the course of glaucoma and when it does, it has been said to have a beneficial effect upon the glaucoma.

J. B. Story (*Ophthalmic Review*, p. 225, Aug., 1911) records two cases of myopia of medium amount in which treatment, both medical and operative, was not very satisfactory so far as central vision was concerned. The perimeter charts are depicted in the text, and show the results of operation especially.



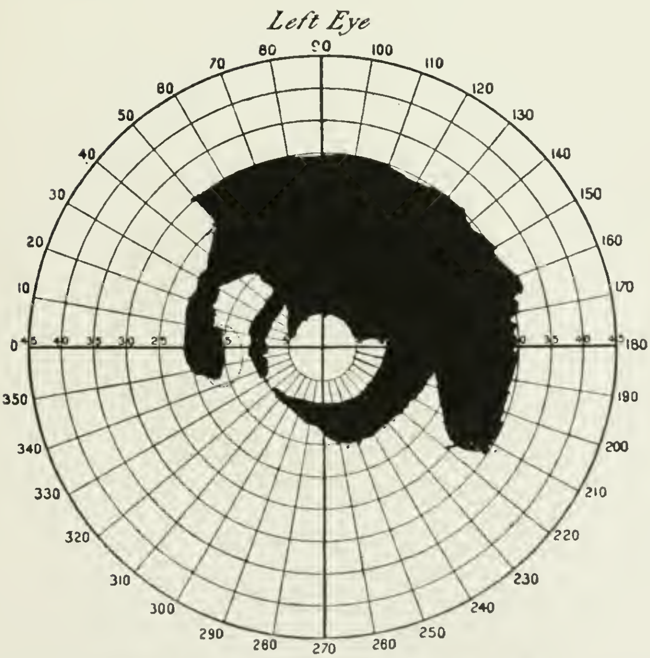
Myopia in Glaucoma. (Story.) First Case.

Chart of central fields. Test object 2mm. square, white. Right eye before iridectomy.



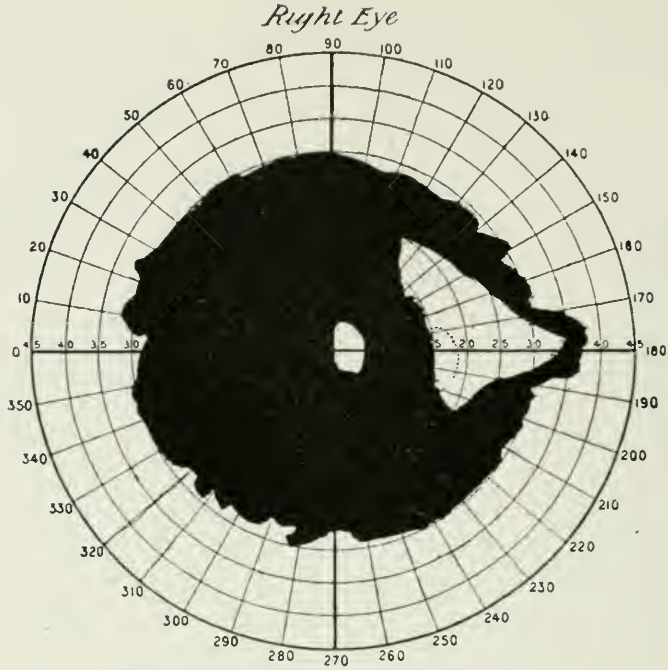
Myopia in Glaucoma. (Story.) First Case.

Chart of central fields. Test object 2mm. square, white. Left eye before iridectomy.



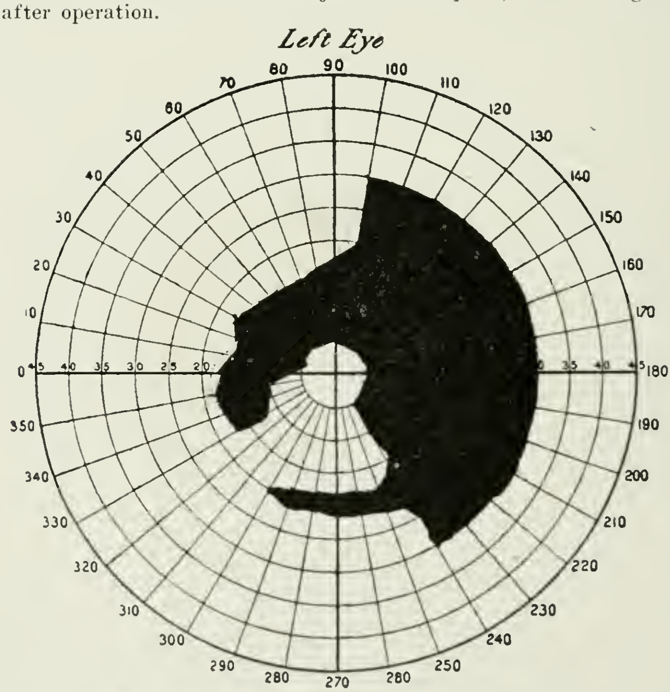
Myopia in Glaucoma. (Story.) First Case.

Chart of central fields. Test object 2mm. square, white. Left eye three weeks after operation.



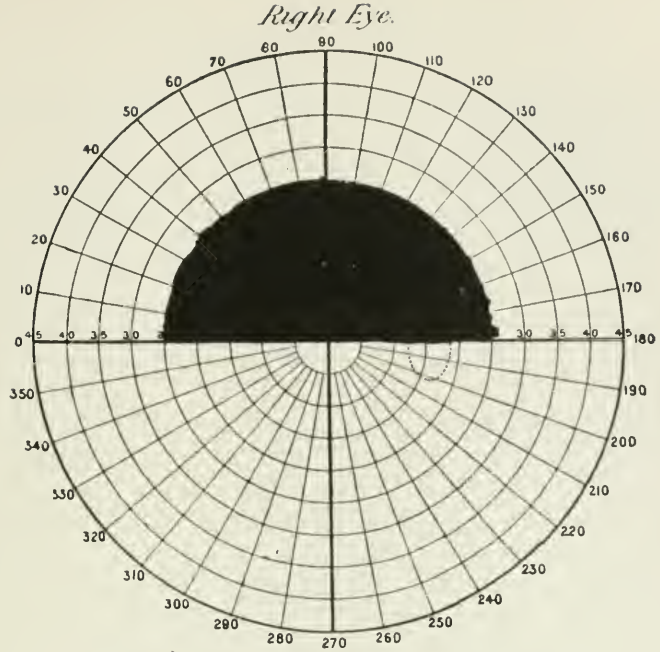
Myopia in Glaucoma. (Story.) First Case.

Chart of central fields. Test object 2mm. square, white. Right eye ten months after operation.



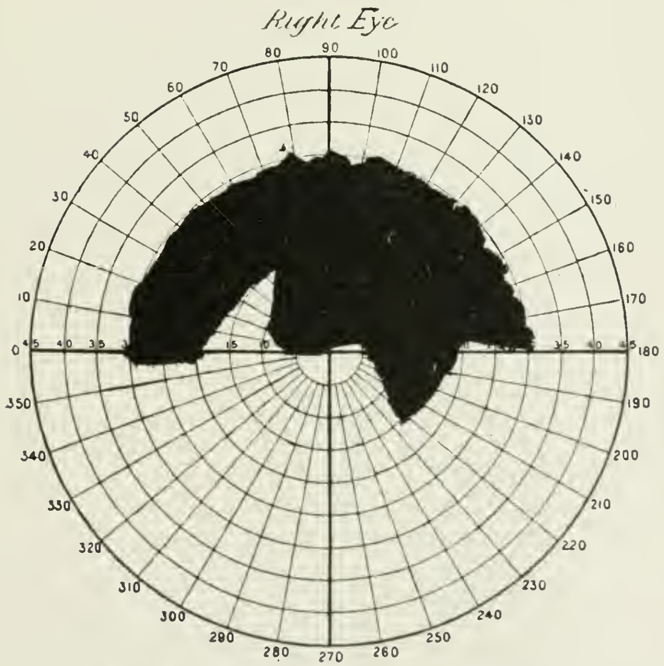
Myopia in Glaucoma. (Story.) First Case.

Chart of central fields. Test object 2mm. square, white. Left eye ten months after operation.



Myopia in Glaucoma. (Story.) Second Case.

Chart of central fields. Test object 2mm. square, grey. Right eye before iridectomy.



Myopia in Glaucoma. (Story.) Second Case.

Chart of central fields. Test object 2mm. square, grey. Right eye three and one-half years later.

Glaucoma neglectum. (G.) A case in which there has been neglect on the part of the patient to apply for relief, or on the side of the surgeon to give it.

Glaucoma prodromale. (G.) The same as *Glaucoma imminens.*

Glaucoma, Posterior. This term indicates that the chief lesions in the disease affect the posterior segment of the eye; for example, in the nerve-head and its vicinity.

Glaucoma simplex. (G.) See **Glaucoma.**

Glaucomatic. GLAUCOMATOSE. GLAUCOMATOUS. Pertaining to or of the nature of glaucoma.

Glaucomatous cavernæ. Fleischer (*Ophthalmology,* July, 1913) found these cavernæ almost regularly in secondary and primary glaucoma, if the excavation was not too far advanced. While Schnabel considered cavernæ as a primary affection of the optic nerve, specific for glaucoma but independent of the increased ocular pressure, the writer's findings were such that the cause for the formation of cavernæ must be attributed to an accumulation of fluid, a lymph stasis, due to disturbances of circulation from the abnormal conditions of tension. Fleischer, therefore, considers the cavernæ to be a secondary process.

Glaucomatous crisis. The acute stage explosion or attack. Same as *glaucoma evolutum* (Graefe).

Glaucomatous vertigo. A term employed by Dor (*La Clinique Ophthal.,* June, 1913) which he says is so common that a history of it can be obtained in 25 per cent. of glaucomatous patients, but which has as yet escaped the attention of ophthalmic surgeons. It occurs even in those who are totally blind; the patients do not connect the symptom with their eye condition and hence do not mention it to the surgeon. He thinks that it is caused by the increase in the ocular tonus, and that it has an analogy with Ménière's disease, which it resembles in many ways clinically. He does not call all cases of vertigo in the glaucomatous by the appellation "glaucomatous vertigo," but restricts the term to those which evidently stand to the glaucoma in the relationship of effect to cause. The point of greatest interest in this connection is that the relief of the glaucomatous condition is at once followed by the cessation of the attacks of vertigo. Dor's patients have very warmly appreciated the benefits thus conferred on them.

Glaucoma Woulhousi. (Obsolete.) A cataract.

Glaucosis. The blindness resulting from glaucoma.

Glaucous. Of a sea-green or grayish-green color; covered with a bloom, like the leaf of the cabbage.

Glede kite. In ancient Greco-Roman times the liver of the glede kite was often employed as a poultice in various diseases of the eye.—(T. H. S.)

Gleditschine. An alkaloid derived from several species of *Gleditschia; e. g.*, Goodman is said to have discovered it in the leaves of *Gleditschia triacanthos.* It has both anesthetic and mydriatic properties. It was at first called *stenocarpine.* Its lack of the properties ascribed to it was soon discovered, and the substance sold as *gleditschine* was suspected to be merely a mixture of cocaine and atropine.

Gleich. (G.) Equal.

Gleichfarbig. (G.) Of the same color, or of uniform color.

Gleichgewicht. (G.) Equipoise; equilibrium; the condition in which contending forces are equal.

Gleichwinkelige Diplopie. (G.) Homonymous diplopia.

Gleize. A distinguished surgeon and ophthalmologist of the later 18th century, whose Christian name and life dates cannot now be ascertained. He was born at Montpellier, became master of surgery, ophthalmologist to the Royal College of Surgery at Orleans, and oculist to the Duke of Orleans and Count of Artois. He was a great braggart, making use of the public journals for the purpose of exploiting his achievements.

He wrote: 1. Nouvelles Observations sur les Pratique Maladies de l'Oeil et leur Traitement. (Paris, 1786: Orléans, 1811.) 2. Réglement de Vie, ou comment Doivent se Gouverner ceux qui sont Affligés de Faiblesse de Vue. (Orléans, 1787.) 3. Mémoire sur l'Ophthalmostate de M. Demours. (*Jour. de Méd., Chirurg. et Pharm.*, 1788.) 4. Mémoire sur les Avantages du Seciton à la Nuque dans les Ophthalmies Humides ou Invetérées. (*Op. cit.*, 1789.) 5. Des Staphylomes. (*Op. cit.*, 1789.)—(T. H. S.)

Glene. (Obs.) The interior of the eye; also, the shallow articular cavity in a bone.

Glenitis. (L.) An old term for phakitis, or "inflammation" of the lens.

Glied. (G.) A member; a limb; a joint.

Glimmerbrillen. (G.) Mica spectacles.

Glioma. Glioma in general. A form of round-celled sarcoma consisting of a tumor of neuroglia cells occurring in the brain, spinal cord and in certain nerves or their nervous expansions.

Besides the interest of the ophthalmologist in this neoplasm, as it affects the optic nerve and retina, gliomatous tumors of the central nervous system may indirectly affect the eye.

Glioma endophytum. A term given to the tumor when it springs from the retina and extends forward into the vitreous towards the anterior portion of the eyeball.

Glioma exophytum. That form of the neoplasm that arising from the retina grows backwards into the sub-retinal space.

Glioma of the optic nerve. True, that is primary, intradural gliomata of the optic nerve are exceedingly rare. Finlay records three of them in a total of 117 neoplasms of the optic nerve. Byers, who has tabulated 102 histories of primary intradural tumors, has recorded six examples of glioma. Foucher (*Ophthalmic Record*, January, 1910) had an opportunity of treating and studying histologically one of these rare and interesting neoplasms. The subject was a boy, aged 2 years and 3 months.

When first seen the right eyeball had become quite prominent, the pupil was dilated and through the transparent media one could see the optic papilla presenting the appearance of an optic neuritis; swollen disk; tortuous, congested vessels on the background, disappearing in places to reappear a little further on; hemorrhages scattered here and there about the arteries and veins. The intra-ocular tension of the globe, as immobile as if it were affected by a complete ophthalmoplegia externa, was very high. Although the child was too young to make the usual tests, vision appeared to be completely abolished; the sudden approach of an object to the right eye, while the left was covered, had no effect upon the child. The patient now began to suffer severe (glaucomatous) pains.

After a careful review of the case the writer concluded that he had to deal with a tumor of the optic nerve proper.

He adds that to facilitate the complete enucleation of the globe and tumor from the orbit he found it necessary to transfix the cornea with needle and suture; probably the needle lacerated the lens and this accounts for the alterations subsequently found in these structures.

No doubt the exophthalmos was not only due to the growth of the orbital tumor but also, in a large measure, to the congestion of the orbital circulation, as we know that even small, extra-ocular growths may cause a decided protrusion of the globe, or a decided proptosis may follow simple enlargement of the intra-orbital optic tissue.

The exophthalmos occurred straight forward and the globe was immovable, thus proving that the tumor more or less perfectly surrounded the eyeball, pushing it almost uniformly forward and preventing its excursions in any direction.

A second examination, made two weeks after the first, showed a decided change in the intra-ocular picture; the papillitis now gave evidence of subsiding and atrophic signs appeared. The increased tension was still quite apparent, the disease being evidently that of a

well-marked glaucoma—with a steamy cornea, widely-dilated pupil, pericorneal injection, enlarged scleral veins and a slight haze of the media.

The mother related the following history: The exophthalmos showed itself about five months previously and was shortly followed by apparent discomfort about the eye, which deepened during the next few weeks into severe pain. With the exception of an instrumental delivery there was no history of traumatism and there had been no examples of tumor in the family for at least four generations, when a paternal ancestor had had cancer.

On considering the possibilities of the case Foucher thought at first that he would remove the growth without sacrificing the eyeball, either by the method of Lagrange or that of Krönlein, but, afterwards, concluded it would hardly be worth the while, in view of the defective vision, the mutilation necessary and the doubt about the exact character of the growth. Consequently he did a simple enucleation, and completely removed the tumor with all its orbital attachments. The patient's recovery was perfect and six months after the operation the family physician wrote that there was no sign of recurrence.

The histologic examination was made by E. P. Carlton, who pronounced the growth to be an intradural glioma of the optic nerve. He was led to this conclusion on finding: 1. That there had been parenchymatous degeneration of the nerve elements. 2. That no edema was noted to explain the enlargement of the nerve, which was about twice the normal diameter. 3. That there had been an enormous proliferation of the interstitial tissues, affecting chiefly the neuroglia; to a much less degree, thickening of the septa. 4. That there was optic neuritis as shown by the large numbers of small round cells and fibroblasts. 5. That there was chronic perineuritis involving the pia and arachnoid as evidenced by an obliteration of the intervaginal space through enormous proliferation of the endothelium and by infiltration with fibroblasts and round cells. 6. That there was a true papillitis due to proliferation and infiltration.

It was noted, also, in the eyeball proper: 1. That the wound in the cornea occurred at the time of enucleation, or shortly before, as there was no evidence of inflammatory reaction or repair. 2. That there had been a pyramidal cataract with adhesions at the site of the corneal wound, followed later by loss of degenerated lens fibers through this wound. 3. That there had been an iritis with posterior synechia. 4. That there was evidence of glaucoma. 5. That the retina had been involved secondarily through the optic nerve. 6. That in neither optic nerve nor tumor was there anywhere noted infiltration with poly-

morphonuclear leucocytes nor was there any other sign of an infection. 7. That the changes in the posterior half of the bulb were secondary to trouble in the nerve, while the changes in the anterior half were secondary to the injury of the cornea and lens.

Another of these rare neoplasms—a ganglionic glioneuroma—is described by G. C. Ruhland (*Jour. Amer. Med. Ass'n*, February 1, 1913). This growth belongs to the rarer forms of nerve tissue tumors, and is found most commonly in the central nervous system and cord.

The patient, a girl, first began to show evidences of eye trouble at the age of six. At the age of eight she contracted scarlet fever with rapidly-developing exophthalmos and complete blindness of the eye. An enucleation was done and an oblong tumor, 3 cm. in length, and 1.5 cm. in width, was found occupying the optic nerve. Microscopic examination showed neurogliar tissue forced apart by hemorrhage and edema, with typical ganglionic cells and nerve fibers. The eyeball was not involved. The tumor was undoubtedly congenital in origin and represents misplaced nerve tissue. Its growth was slow until the febrile condition of the scarlet fever with its accompanying hyperemia stimulated the tumor into an active growth. It was histologically a benign growth and there had been no return during a period of one and one-half years.

Glioma of the retina. Neuroepithelioma retinæ (Flexner). Glioma retinæ. Retinal gliomatosis. Sarcoma of the retina. Fungus hematodes retinæ. This new growth of the retina is of epithelial origin.

Wintersteiner, after an exhaustive microscopic study of these tumors, concluded that they arise from the neuroepithelial layer of the retina, and should be named neuroepitheliomata. According to their location and the direction of growth, the following varieties are distinguished. They exist only in the early stages: 1. Several nodes the size of a pinhead appear in the retina; they grow only slightly toward the vitreous, but spread in the subretinal space. By confluence they form a tuberous deposit on the outer surface of the detached retina: neuroepithelioma exophytum or tuberosum. 2. The detached retina is thickened in its entire extent or in spots; the deposits remain comparatively thin and level; later by proliferation the surface becomes uneven and protuberant: neuroepithelioma diffusum or planum. 3. The new growth increases only in the direction of the vitreous; the retina remains attached to the choroid; the mass spreads upon the inner surface of the retina, to which it is united not closely, but by processes; the vitreous surface of the growth is finely lobulated, cauliflower-like, or nodular: neuroepithelioma endophytum.

Unlike intra-ocular sarcoma, neuroepithelioma is never pigmented. The tumor grows from the two granular layers of the retina, but chiefly from the inner one. The mass is composed of small cells in a soft basement-substance. The cells consist of nuclei surrounded by protoplasm in which minute processes are often found. Some are glia-cells, others are ganglion-cells. The cells are especially numerous along the larger vessels, and this arrangement gives rise to a tubular appearance. Many specimens present long cylindric cells from the neuroepithelium of the retina. These form groups inclosing a free cavity, into which the extremities of the cells project. The retina becomes irregularly thickened, folded, and detached. Small free nodules involve both the choroid and the vitreous humor. Degeneration of the intercellular substance occurs very early.

The cause of neuroepithelioma of the retina is unknown. It is a disease of childhood, no true case having been found after the sixteenth year. Cases heretofore reported of greater age have been found to be either sarcomas of the choroid or pseudo-neuroepitheliomata. Of 467 true cases, 314 occurred during the first three years, 62 in the fourth, and 29 in the fifth year. The disease surely is congenital in 10 per cent. of the cases, and possibly in the majority. Sex is without influence in this disease. In 25 per cent. of the cases both eyes are affected. The second eye becomes involved independently, there being no extension of the disease via the chiasma. The disease often appears in several children of the same family. Lerche saw four cases among seven brothers and sisters and Wilson met with a family of eight, all of whom had neuroepithelioma of the retina.

Usually the first symptom is a peculiar reflex from the interior of the eye, which, from its resemblance to a cat's eye shining in the dark, was named by Beer and the older authors "amaurotic cat's eye." The parents may note that the child does not see with the affected eye. In this, the first stage, there is no pain or redness, the media are clear, the pupil is somewhat dilated, and the child's health is unaffected. Ophthalmoscopic examination shows a whitish, yellowish, or reddish-yellow mass in the fundus. The growth is covered with a plexiform network of vessels and has a smooth or nodulated surface. In this stage the growth increases slowly, and months may pass before the mass fills the globe, thus completing the second stage.

In the third stage there is increased tension. The child becomes fretful, emaciated, and cachectic. The neoplasm enmeshes all the tissues of the globe, and finally breaks out at the corneo-scleral junction in front or at the optic-nerve entrance behind. Once out of the globe it grows rapidly, forming a large, ulcerated mass, which bleeds

at the slightest touch. This condition was named by the older authors "fungus hematodes oculi." Now the organs are involved by contiguity or by metastasis. The optic nerve furnishes a road by which the growth rapidly travels brainward. Metastases may take place in the brain, cranial bones, lymphatic glands, parotid gland, spinal cord, liver, lungs, ovaries, kidneys, submaxillary gland, or spleen. The patient dies of exhaustion.

If the ophthalmoscope shows a whitish tumor, with retinal vessels coursing over it, and the tension is increased, the case probably is one of neuroepithelioma. An error in diagnosis is possible in two directions: a tumor may be present and be overlooked, or a diagnosis of neuroepithelioma may be made, the eyeball may be removed, and the microscopic examination show incorrectness of the diagnosis. Hirschberg's dictum that a diagnosis between true and false retinal tumors is always possible, has been found erroneous. The most careful diagnosticians have often been in error. Of twenty-four eyes removed at Moorfields Hospital between 1888 and 1893 for "glioma," seven were "pseudo" growths. Retinal detachment and suppurative processes in the vitreous humor cause frequent mistakes. The history of the case is always important. The parents should be questioned as to trauma, meningitis, typhoid fever, influenza, and other infectious diseases, since these are followed by diseases of the vitreous humor. If the tension is greatly increased, the case is probably one of neuroepithelioma; if the tension is decidedly reduced, it is not neuroepithelioma. Between these extremes are cases in which tension is normal or changes from time to time. The presence or absence of blood-vessels on the growth is important; if present, the case is probably neuroepithelioma; if absent, the tumor is usually due to an exudative choroiditis. Unfortunately, however, there are neuroepitheliomata which are not vascular; and, on the other hand, exudation into the vitreous humor sometimes becomes vascularized. The "amaurotic eye" reflex is valueless in differential diagnosis. The conditions often mistaken for neuroepithelioma, according to Wintersteiner are: 1. Simple detachment of the retina. This is comparatively rare in childhood. Although a tumor shows a more yellowish or reddish color than a detachment, which is of a bluish tint as a rule, yet it must be remembered that, with a small tumor and a large detachment of the retina, the folds of the latter can completely conceal a neoplasm; and although the newly formed vessels of a tumor generally present a course and ramifications different from those of the retinal vessels, yet, on the other hand, there are cases which show almost no vessels. Although, as a rule, a retina which is lifted up by serous effusion

vibrates and floats when the eye is moved, while a retina detached by a tumor remains at rest, yet exceptions occur. The statement that in simple retinal detachment the tension is reduced and in intra-ocular tumor it is increased must be accepted with allowances, for in the first stage of neuroepithelioma tension is normal, and, on the other hand, in serous detachment it is often increased.

2. Leucosarcoma of the choroid. This is a comparatively rare disease in childhood. Of 259 sarcomas of the uveal tract, Fuchs found 6 leucosarcomas in children under twelve years of age. In these cases the symptoms of intra-ocular tumor are added to those of retinal detachment. The diagnosis is particularly difficult if the media are opaque or if the choroidal tumor perforates the globe posteriorly without causing retinal detachment.

3. Tubercles in the choroid. Here the history of the case is important. Miliary tubercles of the choroid are usually found near the optic-nerve entrance in the macular region. They appear as whitish-yellow masses or nodules in the stroma of the choroid, varying in size from one-eighth the diameter of the optic disc to the size of the disc itself. By confluence they sometimes form large masses. A rare condition is solitary tubercle, which appears as a nodule and resembles a beginning neuroepithelioma. Diagnosis is particularly difficult in cases where the vitreous chamber is filled with granulation tissue, and in consequence of secondary glaucoma scleral ectasia appears.

The diagnostic difficulties are shown by two cases reported by Jung. In the first neuroepithelioma was diagnosticated and tuberculosis was found; the second was regarded as tubercular and a tumor was found.

4. Chronic inflammatory processes in the choroid and ciliary body. These are the conditions most often causing error. They show retinal detachment and the presence of a fibrinous vitreous exudate, which later becomes organized. The chief points in differential diagnosis are these: (a) In exudative choroiditis the color of the vitreous mass is a metallic, brass-like yellow, while in the retinal neoplasm whitish, yellowish, reddish, and green tints are seen; yet even here the metallic lustre may be observed. (b) Many observers state that the exudate is non-vascular, while a retinal tumor possesses vessels. Others equally competent report cases of true neoplasm in which vessels were never visible to ophthalmoscopic examination; and, on the other hand, an exudate into the vitreous often undergoes organization. (c) The surface of a tumor is knobbed; that of an exudate is smooth or ragged. A tumor growing into the vitreous may have a smooth surface if it presses against the lens, while an exudate may become shrunken and

conglobate. In such cases it may be impossible to make a diagnosis microscopically even after enucleation. A tumor with a smooth surface may be a neuroepithelioma growing chiefly into the retina. (d) Early in neuroepithelioma of the retina the tension is normal; later it is increased. In vitreous exudation it is usually diminished. Yet there are exceptions. The author has seen one case of pseudo-glioma with increased tension. (e) Posterior synechiæ and other evidences of iridal inflammation are not reliable, since they may be present or absent in each condition.

5. Acute suppurative hyalitis producing a yellow mass behind the lens, inflammatory symptoms, and increased tension can be mistaken for a neoplasm. The rapid course of the disease, the presence of hypopyon, scleral perforation, and the discharge of pus will serve to clear the diagnosis.

6. Cysticercus in the vitreous can scarcely be a cause of mistaken diagnosis in this country, since it is an extremely rare disease in America, although common in Germany. It appears as a bluish-white mass in the vitreous, without vessels, with normal tension and blindness.

7. Congenital abnormalities. In some instances eyes have been enucleated for neoplasm and examination showed persistent vascularity of the lens-capsule, and a hyaloid artery with posterior polar cataract.

8. Retinitis circinata, when occurring in children, may be mistaken for neuroepithelioma of the retina.

9. Detachment of the retina with dropsical degeneration of the visual cells (rods and cones), according to de Schweinitz and Shumway, may exactly resemble neuroepithelioma.

This is always a serious disease, but the prognosis depends upon the stage of the condition. Without treatment neuroepithelioma of the retina always causes death. Early operations are followed by 13 per cent. of recoveries. If the growth has penetrated the eyeball, and particularly if perforation occurs posteriorly, death is almost sure; but operation will probably prolong life. Operation for recurrence is useless. It is said that if the disease does not return within four years the patient will be exempt.

The treatment of neuroepithelioma retinæ should be early and heroic. Any suspicious growth within the eye of a child calls for immediate enucleation and removal of the orbital part of the optic nerve as far back as possible. The eye should then be submitted to a competent pathologist for microscopic diagnosis. If found to be true neuroepithelioma retinæ, the orbital contents should be removed. This

leaves a great deformity, but increases the chance of saving life. In cases where the neoplasm has already pierced the globe exenteration of the orbit should be done immediately, unless the disease has progressed so far that the patient cannot recover from the depression of the anesthetic and operation. If the neoplasm has invaded the cavities adjacent to the orbit, operation is contra-indicated. In a case with involvement of both eyes the same principles of treatment should apply.—(J. M. B.)

Cures after ablation of glioma of the retina are rare enough to warrant the publication of those cases which come under observation. For this reason de Speville (*La Clinique Ophtal.*, March 25, 1906) reports a case. The patient, a robust child of 3 years, had never been sick; five other children in the family all healthy. The father is gouty and suffers from migraine and gastric crises; mother has always had good health. The parents had observed that for two months the left eye had a peculiar aspect when turned toward the right. The eye externally presented nothing abnormal; central vision was excellent. When the eye was directed towards the right the pupillary reflex very clearly gave the so-called "amaurotic cat's eye." The ophthalmoscope demonstrated in the internal portion a whitish-yellow tumor about the size of a pea pushing into the vitreous humor. The neoplasm was hidden by the iris when looking at the macula, which latter region was normal, as also were the upper external portions of the fundus. In the inferior equatorial regions were several small limited tumors presenting the aspect of white cotton. Microscopic examination of the enucleated tumor proved it to be a typical exophytic glioma. The child was, eight years afterwards, perfectly healthy.

Further evidence on the important subject of prognosis is furnished by De Kleijn (v. Graefe's *Archiv für Ophthalm.*, Vol. 80, No. 2, p. 371, 1912). Of eighteen cases of glioma retinæ operated on in Utrecht eight recovered. The condition of the optic nerve was not known in one of these, in four it was free, in two affected peripherally, and in the remaining one it was completely involved as far as the section.

In this case, which occurred in a child of eight months, the histological structure of the tumor was typically gliomatous so that the diagnosis was beyond doubt. Three months afterwards the other eye was found to be affected and, under the circumstances, enucleation was postponed until it should become painful. The child was not brought back but was found four years subsequently in an asylum, blind but in good health. The remaining eye was atrophic and absolutely blind; a year later it was removed as a precautionary measure.

Microscopical examination showed the characteristic features of atrophy of the bulb. The sclera contained a partly bony, partly calcareous mass in which here and there portions of necrotic tissue showing traces of a small-celled structure occurred. The retina could not be seen and the optic nerve was completely atrophied.

Although microscopically it was not possible to demonstrate glioma tissue in the second eye the author considers the diagnosis of glioma well justified and attributes the outcome of the case to some unknown factor which, in the contest between the tumor and its host, turned the scale in favor of the latter. (H. M. Traquair, in *Oph. Rev.*, p. 78, 1913.) See, also, **Tumors of the eye.**

Glioma, Pseudo-. Cryptoglioma. Certain forms of exudative uveitis, simulating the appearance of retinal glioma. See page 3573, Vol. V, of this *Encyclopedia.*

Glioma retinæ luxurians. A term applied by Schöbl (*System of Diseases of the Eye,* Vol. III, p. 554) to a rare group of gliomata in which, for a long period, regressive metamorphoses are not observed, or concern only very small portions of the growth. In such tumors all the cells remain fresh and alive and can be stained with hematoxylin. Their blood-vessels show hardly any signs of degeneration. The tumors usually preserve much longer that ramification of the blood vessels characteristic of young gliomata. There are no large hemorrhages. These tumors grow relatively quickly, and in sections appear uniform from their original site to the edge of the exophthalmic mass.

Glioma teleangeiectaticum. A form of glioma in which the blood-vessels are numerous and dilated.

Gliomatosis. (L.) The formation of a glioma.

Gliosis. Fibrous degeneration. The condition of being affected or attacked by a fibromatous tumor or process; or by changes occurring in the neuroglia. Parsons (*Pathology of the Eye*, p. 576) says of *gliosis retinæ* that it has been seen not only in inflammatory conditions but even more in chronic venous congestion from heart failure, etc. It is also noticed in senile degeneration, wounds, etc. In most cases the retina is much atrophied; and there is no proof that more neuroglia is present than could be accounted for by the persistence of the normal tissue, which shows little tendency to become absorbed. The condition corresponds with that which is usually termed *fibrous degeneration* in England. The view that the tissue which persists, and also the new-formed tissue, when any is present, is neuroglia depends chiefly on staining reactions, particularly a yellow coloration with van Gieson. These reactions are open to doubt as

final criteria of the tissue genesis, and the doubt is emphasised in this case by the fact that the normal neuroglia of the retina does not stain specifically with many of the specific stains for the neuroglia of the central nervous system. There is an abundance of evidence that the greater part of the new-formed fibrous tissue which is found in inflamed or degenerated retinæ is of mesoblastic origin, and is therefore derived from the walls of the blood vessels or from the choroid. There is no evidence that the cells of the vitreous can proliferate and produce fibrous tissue.

In the condition known as gliosis the glia-cells are said to be increased and the fibres thickened. The nuclei are increased in the nerve-fibre layer, and nuclei appear in the reticular layers, in which they are absent or scanty under normal conditions. Müller's fibres are said to be thickened and the glia network is coarser and more obvious, especially in the inner reticular layer. This thickening is to a large extent relative rather than absolute, owing to the degeneration of the true nervous tissues. The increase in nuclei is partly relative, many being remnants of the nuclear layers, but undoubtedly in part absolute, being due to infiltrating cells and others of connecting-tissue origin.

Neurological fibres are described as streaming out into the vitreous, as in retinitis proliferans, and into the choroid, as in choroido-retinitis. In the latter case it is far more probable that the fibres are choroidal in origin, while in the former they are mostly derived from the retinal vessel walls.

Glitterance. A term of doubtful origin, used to indicate a neoplasm of the retina.

Globe. A name for the eyeball; the globe of the eye.

Globe de l'oeil. (F.) Eyeball.

Globe d'une bande. (F.) A rolled-up bandage.

Globe lens. A lens consisting of two achromatic and identical convergent meniscus lenses, so arranged that the outer surfaces form a sphere.

Globe oculaire. (F.) Eyeball.

Globe of the eye. The eyeball.

Globe-tube. A disused term, applied to a lens system having an aperture of nearly ninety degrees.

Globoid. Globose. Globuloid. Approximately globular.

Globule de l'oeil. (F.) Eyeball.

Globules, Morgagni's. Morgagni's spheres. Small hyaline bodies found between the crystalline lens and its capsule before and after death.

especially in cases of cataract. They are due to coagulation of the albuminous fluid contained in the lens.

Globulet. A minute globulose particle.

Glomus. (L.) A name given by Wenzels to the portion of the choroid plexus of the lateral ventricle that covers the optic thalamus.

Glossina morsitans. The (African) tsetse fly.

Glosso-labio-pharyngeal paralysis. BULBAR PARALYSIS. In rare cases the progress of the disease upwards affects one or more oculo-muscular centres, above all the rectus externus and the levator palpebræ superioris. See **Bulbar paralysis** and **Neurology of the eye.**

Gloster. The central figure of the sub-plot in Shakespeare's "King Lear." After his betrayal by his bastard son, Edmund, his eyes were torn from their sockets by the detestable Cornwall. The passage in which this unspeakable outrage occurs, is to be found in Act III, Scene VII, and runs as follows:

Enter GLOSTER, *brought in by two or three.*

Regan. Ingrateful fox! 't is he.

Cornwall. Bind fast his corky arms.

Gloster. What means your graces?—Good my friends, consider.
You are my guests; do me no foul play, friends.

Cornwall. Bind him, I say.

Regan. Hard, hard.—O filthy traitor!

Gloster. Unmerciful lady as you are, I'm none.

Cornwall. To this chair bind him.—Villain, thou shalt find—

[*Regan plucks his beard.*

Gloster. By the kind gods, 't is most ignobly done. To pluck me by the beard.

Regan. So white, and such a traitor!

Gloster. Naughty lady,
These hairs which thou dost ravish from my chin
Will quicken and accuse thee. I am your host;
With robbers' hands my hospitable favors
You should not ruffle thus. What will you do?

Cornwall. Come, sir. what letters had you late from France?

Regan. Be simple-answer'd, for we know the truth.

Cornwall. And what confederacy have you with the traitors late footed in the kingdom?

Regan. To whose hands have you sent the lunatic king? Speak.

Gloster. I have a letter guessingly set down,
Which came from one that's of a neutral heart,
And not from one oppos'd.

Cornwall. Cunning.

Regan. And false.

Cornwall. Where hast thou sent the king?

Gloster. To Dover.

Regan. Wherefore to Dover?—Wast thou not charg'd at peril—

Cornwall. Wherefore to Dover?—Let him first answer that.

Gloster. I am tied to the stake, and I must stand the course.

Regan. Wherefore to Dover?

Gloster. Because I would not see thy cruel nails
Pluck out his poor old eyes, nor thy fierce sister
In his anointed flesh stick boarish fangs.
The sea, with such a storm as his bare head
In hell-black night endur'd, would have buoy'd up,
And quench'd the stelled fires;
Yet, poor old heart, he holp the heavens to rain.
If wolves had at thy gate howl'd that stern time,
Thou shouldst have said, 'Good porter, turn the key,
All cruels else subscribe.' But I shall see
The winged vengeance overtake such children.

Cornwall. See't shalt thou never.—Fellows, hold the chair.—
Upon these eyes of thine I'll set my foot.

Gloster. He that will think to live till he be old,
Give me some help!—O cruel! O you gods!

Regan. One side will mock another; the other too.

Cornwall. If you see vengeance—

1 *Servant.* Hold your hand, my lord!
I have serv'd you ever since I was a child;
But better service have I never done you
Than now to bid you hold.

Regan. How now, you dog!

1 *Servant.* If you did wear a beard upon your chin,
I'd shake it on this quarrel. What do you mean?

Cornwall. My villain! [*They draw and fight.*

1 *Servant.* Nay, then, come on, and take the chance of anger.

Regan. Give me thy sword.—A peasant stand up thus!
[*Takes a sword, and runs at him behind*

1 *Servant.* O, I am slain!—My lord, you have one eye left
To see some mischief on him.—O! [*Dies.*

Cornwall. Lest it see more, prevent it.—Out, vile jelly!
Where is thy lustre now?

Gloster. All dark and comfortless.—Where's my son Edmund?—
Edmund, enkindle all the sparks of nature,
To quit this horrid act.

Regan. Out, treacherous villain!
Thou call'st on him that hates thee; it was he
That made the overture of thy treasons to us,
Who is too good to pity thee.
Gloster. O my follies! then Edgar was abus'd.—
Kind gods, forgive me that, and prosper him!
Regan. Go thrust him out at gates, and let him smell
His way to Dover.—[*Exit one with Gloster.*] How is't, my lord?
How look you?
Cornwall. I have receiv'd a hurt; follow me, lady.—
Turn out that eyeless villain; throw this slave
Upon the dunghill.—Regan, I bleed apace;
Untimely comes this hurt. Give me your arm.—(T. H. S.)

Glottiscope. A mirror devised for introduction into the mouth for examining the glottis and adjacent parts.

Glotzäugig. (G.) Exophthalmic; affected with exophthalmia; goggle-eyed.

Glotzenauge. (G.) Abnormal protrusion of the eyeball.

Glotzenaugenkropf. (G.) Exophthalmic goitre.

Glucose. GRAPE-SUGAR. DEXTROSE. This form of maize (corn) sugar is found in honey, grapes, and other fruits. It is a colorless, crystalline compound, soluble in water, capable of turning a ray of polarized light to the right; hence its name, *dextrose.* It is a constituent, especially in pathological states, of the urine and the blood. See **Diabetes, Ocular relations of**; also **Glycosuria.**

Glycamyl. See **Glycerite of starch.**

Glycéré. (F.) A medicine having glycerine as the excipient.

Glycerin. GLYCEROL. $C_3H_5(OH)_3$. TRIHYDRIC ALCOHOL. This agent is a colorless, viscid, sweet, soluble liquid found in fats and fixed oils (4-7 per cent.) in combination with the fatty acids, as compound ethers. It is mostly obtained as a by-product in the manufacture of soap. Glycerine is very hygroscopic and mixes in all proportions with water and alcohol.

Glycerine is used as a solvent of or in chemical combination with other agents to form compounds known as (glycerita, glycerina) glycerols, glycerides, glycerites or glycerins (B. P.), quite a number of which are used in ocular diseases. In addition to this employment of the remedy it is sometimes added to ointments, or even directly applied, in full strength or diluted with half its bulk of water, to the conjunctiva where it acts as a mild stimulant, antiseptic (?) and protective. After pencilings with blue stone, lapis divinus or silver

nitrate it may be applied with a brush to limit the caustic action of the drug. It is an admirable excipient for copper sulphate in trachoma and may be used in saturated solution or diluted with water to the extent desired. It also dissolves iodine, phenol and other ocular remedies, making with them solutions that are readily applicable to the eye structures.

Harman (*Prac. Med. Series*, p. 254, 1909) has found a glycerin formula which reduces the pain caused by nitrate of silver. He adds 15 per cent. of pure glycerin to a 0.5, 1 or 2 per cent. solution of silver nitrate in distilled water. This raises the specific gravity of the nitrate and increases its penetrative action on account of the hygroscopic powers of glycerin. He has used this preparation on a large number of patients, and finds it distinctly less painful than the ordinary solution of nitrate of silver, and rather more effective. The salt does not lose in caustic action, since a fine pellicle of destroyed epithelium can be seen, but the pain is reduced by the action being spread over a longer period. See **Glycerites**; also, **Glycerita.**

Glycerin of alum. See **Glycerite of alum.**

Glycerin of borax. See **Glycerite of borax.**

Glycerin of starch. See **Glycerite of starch.**

Glycerin of tannin. See **Glycerite of tannin or tannic acid.**

Glycerita. See **Glycerites**; also **Glycerine.**

Glycerite of alum. Glycerin of alum. This is a convenient preparation containing about one part of alum dissolved in eight parts of glycerin. Its ocular uses are the same as alum.

Glycerite of borax. Glycerin of borax. This preparation contains one part of borax to six of glycerin. Diluted with a varying quantity of water this mixture, that always has a little free boric acid, is used by some ophthalmologists as a collyrium.

Glycerite of hydrastis. This is an official mixture intended to furnish a fluid preparation of hydrastis, miscible with water in all proportions. Each cc. represents 1 grm., or 463 grains, of hydrastis to the fluid ounce.

Glycerite of starch. Glycamyl. Plasma. Glycerin of starch. A homogeneous, neutral, jelly-like mass containing 10 per cent. each of starch and glycerine with 80 per cent. of water. It is an emollient application useful in burns of the face and eyelids, may be used to remove iodine stains and has been employed as a medium for other applications to the external eye.

Glycerite of tannin or tannic acid. Glycerin of tannin. This compound contains 20 per cent. of tannin and 80 per cent. of glycerin and

forms a brownish solution that can be conveniently applied as an astringent in those ocular conditions (trachoma, follicular conjunctivitis) in which tannic acid is useful.

Glycerite or glyceride of boric acid. See **Boroglycerin.**

Glycerites. Glycerita. The glycerites are solutions of medicinal substances in glycerin. Although all are intended to be used internally, except that called boroglycerin, yet all are adapted for external application. Glycerite of yolk of egg (no longer official), which should be freshly made when wanted, is frequently used for making emulsions of cod-liver oil and as a vehicle for other substances, e. g., it may be employed as a menstruum in eye lotions.

Glycerol. See **Glycerine.**

Glyceryl borate. See **Boroglycerin.**

Glycocromyda. (L.) A sweetish onion, growing to the weight of a pound on the (Greek) island of Tenos. Eaten moderately, it is said to be wholesome, but if immoderately used, to weaken the sight.

Glycogen. Animal starch. This is a white, amorphous, odorless, tasteless powder, insoluble in alcohol but forming an opalescent solution with water. It occurs normally in the liver and blood, being elaborated by the former. It is transformed by diastasic ferments into glucose. It is found, pathologically, in various parts of the eye, especially in spring catarrh, some corneal degenerations, in some forms of iritis and usually in association with hyaline deposits. Parsons (*Pathology of the Eye*, p. 516) describes it as appearing in the form of globules and sickle-shaped deposits in hardened specimens. It is best seen in fresh preparations, but also after hardening in absolute alcohol. It is soluble in saliva; it stains brown with Lugol's iodine solution, and is then soluble in water and more so in glycerine. It often stains by Weigert's method; this also attacks the pigment. It does not stain with iodine and sulphuric acid, methyl violet or acid fuchsin; it stains with carbol fuchsin. Best gives the following directions for staining: (1) Stain with strong solution of iodine in potassium iodide and 50 per cent. alcohol; wash out in iodized absolute alcohol; origanum oil balsam; (2) stain 15 to 30 minutes in carbol fuchsin, wash rapidly in ½ per cent. hydrochloric acid alcohol, decolorize quickly in absolute alcohol. The sections may be previously counter-stained with hematoxylin.

Glycosuria. The secretion of an abnormal quantity of glucose with the urine; chief sign of diabetes mellitus.

Glycosuric cataract. Diabetic cataract. See **Diabetes**; as well as **Cataract, Diabetic.**

Glycosuric retinitis. Diabetic retinitis. See page 3924, Vol. V, of this *Encyclopedia*, as well as **Retinitis, Diabetic.**

Glycothymoline. A proprietary article employed in catarrhal conditions of mucous membranes. It is occasionally used in ocular therapy and is said to contain potassium carbonate, sodium benzoate, sodium borate, smaller portions of sodium salicylate, thymol, menthol, glycerin and alcohol, colored with cochineal.

R. L. Randolph usually treats cases of dacryocystitis by irrigation and the solution which he has found most useful is glycothymoline (Kress) commencing with equal parts of water and glycothymoline and finally irrigating regularly with the undiluted preparation.

H. McI. Morton finds the following collyrium when used in an eye-cup of especial advantage in many forms of simple conjunctivitis: Acid boric., gr. 300; sodii borat., gr. 200; hydrarg. chlor. corros., gr. 1-12; glycothymol., fl. ʒi; aquæ dest. ad., fl. ʒxii.

Glycozone. A proprietary liquid agent said by the maker, Marchand, to be a stable chemical compound resulting from the action of ozone on pure glycerin. It has a pleasant, sweetish-acid taste and may be used for much the same purposes that the official hydrogen dioxide water is employed.

Gnat. Culex giganteus. Mosquito. The damage done to the eye by the stings of this and similar insects is generally confined to edema and localized inflammation of the lid skin, or conjunctiva, although it sometimes ends in suppuration of the part affected. The treatment consists chiefly in the early external use of iced fomentations with lead water; or of iced water to which a few drops of liq. ammoniæ have been added.

Goat. The products of the goat were highly esteemed in Greek and Greco-Roman antiquity. The dung of the animal, wrapped in wax, was swallowed during the new moon for excessive discharge from the eyes (*lippitudo*). Goat's milk was thought to possess an all-round value as a sharpener of the vision, while a poultice of goat's cheese mixed with honey was applied for ocular ulcers. Almost all the products of the goat, moreover, were supposed to be sovereign remedies for nyctalopia (q. v.): the flesh, the blood, the milk, the dung. This curious supposition was based on still another: that, namely, the vision of the goat is fully as sharp by night as it is in daytime.—(T. H. S.)

Goat's horn. See **Tragacanth.**

Gober, Prince Ali. A Great Mogul, who was blinded by his vizier, Gholam Kadir. See **Shah Allum.**

Goblet-cell. This is a form of epithelial cell filled with mucin and bulged out in the shape mentioned. They are found in the mucous membranes of the body; in the eye they resemble somewhat the goblet-cells of the intestine. They are everywhere found as a normal structure in the conjunctival epithelium—especially of the ocular conjunctiva and of the fornix. Parsons (*Pathology,* p. 31) says of the ocular goblet-cells that in the fresh state they are large round or oval cells, strongly refractile and much like fat cells. They are found at various depths, the deeper ones being smaller and round, the superficial ones oval and larger than the epithelial cells (25μ by 16μ) and possessing a definite opening or stoma on the surface. They have a double-contoured membrane or theca, and a pointed process below, which often reaches down to the basement membrane. The main contents of the cell consist of mucin, which forms homogeneous or finely granular droplets when fresh, and larger granules or networks when hardened. This secretion pushes aside the cytoplasm, which is almost invisible, and the flattened nucleus forms a crescent at the base. The latter may be apparently absent in thin sections owing to the size of the cells. Only the superficial cells have a stoma, and the mucin is often seen protruding from it. The stomata are well displayed in surface preparations when the outlines of the neighboring cells are marked by silver staining. The secretion stains very variously. It is more or less extracted during the process of hardening, unless fixed by acetic acid, and even then stains variously, owing probably to the presence of intermediate products (mucinogen). The fresh mucin usually stains with hematoxylin and basic aniline dyes, best with thionin. The superficial cells give the best thionin reaction, owing to the greater quantity of the final product (mucin) present.

Leydig (1857) first discovered such cells in the epidermis of the fish, and called them "mucous cells" (Schleimzellen). They were called "goblet-cells" (Becherzellen) by Schulze (1863), as it was doubtful if they all contained mucin. Stieda (1867) first found them in the conjunctiva, and called them "unicellular mucous glands."

Waldeyer (1874) adopted this idea, pointing out the tendency of the cylinder cells to become metamorphosed into goblet-cells. Now these cells are found in far greater numbers in conditions of chronic inflammation, so that Sattler (1877) looked upon them as pathological. They are also more numerous in tumors (papillomata, etc.). Since, however, they occur in the fetus and new-born, and were found by Green in thirty consecutive normal conjunctivæ, they may be regarded as normal, though subject to great and even enormous increase under pathological conditions. Stieda, in 1890, altered his previous opinion

that they were secretory cells, and regarded them as degenerated cells. It seems probable, indeed, that the cells are destroyed after they have expelled their contents, secretory activity ending in destruction; and in this respect they may be compared with the cells of the active mammary gland. Though resembling the goblet-cells of the intestine, they are not identical with them. The latter are formed only upon the surface, and regenerate after expelling their contents. The former are much more nearly allied to the epiblastic cells described by Leydig in fishes and the larvæ of amphibia (Pfitzner). They are apparently formed only from the cylindrical cells, i. e., mostly from the deepest layer, remain closed as they pass toward the surface, still retaining a filamentary connection with the basement membrane, and finally open upon the surface, expelling their contents, thereby being destroyed. Their function can hardly be considered doubtful. They are true unicellular mucous glands moistening and protecting the conjunctiva and cornea, so that even extirpation of the lachrymal gland is innocuous; whilst, on the other hand, xerosis of the conjunctiva, involving their destruction, leads to desiccation in spite of a copious flow of tears.

Godman, John D. A brilliant American surgeon, who first reported a case of so-called "inverted vision." Born at Annapolis, Md., Dec. 30, 1794, he lost his mother when he was only two years old, and his father in less than three years later. The story of the orphan's uphill efforts for an education is truly pitiful. Suffice it, however, in these pages, to give the barest outline of this remarkable physician's very brief life. In 1815 he began to live and study with a Doctor Luckey, of Elizabethtown, Pa., but, five months later, removed to Baltimore, where he lived and studied with Dr. Davidge, of the University of Maryland. In 1818, at this institution, he received his medical degree. He practised for a time in New Holland, but soon removed to Philadelphia. In 1821, on the invitation of Dr. Daniel Drake, he removed to Cincinnati in order to accept the chair of surgery in the Medical College of Ohio. After a single lecture there occurred a quarrel in the faculty, and he resigned. He established then *The Western Quarterly Reporter*, which lived for a year and a half.

In 1822 he returned to Philadelphia, and, taking rooms, began to deliver a course of private lectures on anatomy. In a very short time his reputation was established. He also wrote a number of brilliant books and articles on subjects connected with natural history, of which the most important is *American Natural History* (3 vols., 1826). He

was one of the editors of *The American Journal of the Medical Sciences* from 1824 until his death.

Godman's most important ophthalmologic article is entitled "Note of an Interesting Fact Connected with the Physiology of Vision," from which I copy the following passage, from Hubbell's "*Ophthalmology in America*" (p. 123): "The following instance communicated to me by Reuben Peale, Esq., the uncle of the young man, is the only one with which we are at present acquainted, where the inversion of objects on the retina was productive of inaccuracy of judgment as to

John D. Godman.

position, notwithstanding all the other senses were in their ordinary condition, and the individual had arrived at the age of 7 years.

"When his father, who was a distinguished artist, began to give him lessons in drawing, he was very much surprised to find that whatever object he attempted to delineate, he uniformly inverted. If ordered to make a drawing of a candle and candlestick set before him, he invariably drew it with the base represented in the air and the flame downwards. If it was a chair or a table he was set to copy, the same result was the consequence; the feet were represented in the air, and the upper part of the object, whatever it might be, was turned to the ground. His father, perplexed at what he considered

the perverseness of the boy, threatened, and even did punish him for his supposed folly. When questioned on the subject the youth stated that he drew the objects exactly as he saw them, and as his drawings were in other respects quite accurate, there was no reason to doubt his statement. Whenever an object was inverted previous to his drawing it, the drawing was made to represent it in its proper position, showing that the sensations he received from the eye were exactly correspondent with the inverted pictures formed on the retina. This condition of his vision was observed to continue for more than a year, when his case gradually ceased to attract attention, which was when he was about 8 years old. Since that time he has imperceptibly acquired the habit of seeing things in their actual position."

Godman married, in October, 1821, a daughter of Peale, the artist. He died in 1830, when only 36 years of age.—(T. H. S.)

Goebel's discission fork. In operations for secondary cataract three errors must be avoided as much as possible, viz., larger openings of the anterior chamber, escape of aqueous, traction on the ciliary body, deep penetration into, and injury of, the vitreous. In order to attain this better than with the instruments so far in use Goebel (*Prac. Med. Series,* p. 236, 1910) has devised a discission fork, which after being introduced behind the cataractous membrane, establishes a firm layer of resistance. The prongs of the instrument consist of two parallel discission needles from 1 to 2 mm. distant from one another, forming with the handle an angle of from 110 to 160 degrees. It is inserted subconjunctivally from the nasal limbus and at the margin of the iris, or eventually through the iris into the secondary cataract, advanced under this more or less over the opposite margin of the iris, and lifted forwards toward Knapp's needle-knife, which, also subconjunctivally, has been introduced from the temporal limbus. With slow and sawing movements the membrane is cut between the prongs. If necessary, a vertical incision may be added. The writer does not doubt that the thickest iritic membranes can thus be easily and safely severed without exerting any dangerous traction on the ciliary body.

Goethe, Johann Wolfgang. The life of this versatile writer is of interest to ophthalmologists on account of his original theories of color-vision, which appeared in his "*Zur Farbenlehre,*" published in 1810 (referred to on page 2420, Vol. IV, of this *Encyclopedia*). He was born in 1749 in Frankfort-on-the-Main, Germany. His father was a doctor of laws and obtained the title of imperial councilor. He was quick to learn and had the advantage of careful instruction from his father and from tutors. The French theatre which opened in the city attracted the boy, and thus he became familiar with Racine and

the more recent dramatists. Latin, Greek, Italian, English, even Hebrew, were studied, and he planned a kind of prose fiction maintained by several correspondents in various languages. At the age of 16 he was admitted as a student in the University of Leipzig. Three years later he was seriously ill, and during this period under the guidance of his doctor he made a study of alchemy which was of service to him later on when he wrote *Faust.* After obtaining his doctor's degree, at the University of Strasburg in 1771, he returned to his native city and was admitted an advocate, but had no heart in his profession. His creative genius was aroused and when he read Shakespeare he felt himself moved to something like rivalry. During the next five years works of the most varied description were written. Some of his most exquisite lyrics belong to 1775. A new period of activity began with Goethe's entrance to Weimar. In 1776 he was made a member of the privy-council (*Geheimer Legationsrath*), and he set himself strenuously to serve the state. He acquitted himself of every duty with masterly intelligence and a rare thoroughness. In 1782 he received a patent of nobility, and during the next ten years his mind seemed to turn away from vague aspirings and sentimental moods to the definite and the real. He became deeply interested in the natural sciences—geology and mineralogy, botany, comparative anatomy. Many literary works were begun in this period but not many completed. He visited Italy at this time, re-entering Weimar in 1788, and bringing back to his home a beautiful girl of humble rank, Christiane Vulpius. His son August was born the following year. Although from the first he regarded Christiane as his wife, the marriage ceremony was not celebrated until 1806. Christiane had good qualities and was dear to Goethe, but his choice was in many respects unsuitable. Science continued to interest Goethe profoundly. His remarkable essay on the *Metamorphosis of Plants* appeared in 1790, and while in Venice in May, he suddenly struck out his much discussed theory of the vertebral structure of the skull. In 1791 Goethe was intrusted with the control of the court theatre at Weimar, and it was his aim and earnest effort to make the stage a means of true artistic culture. About this time appeared his *Venetian Epigrams, Grosskoplita, Die Aufgeregten, Bürger-general* (acted in 1793), and *Reynard the Fox.* In 1792 Goethe accompanied the duke on the disastrous campaign against the French; he heard the cannonade at Valmy, went under fire in order to study his own sensations, and was present at the siege of Mainz. He has recorded his experiences and observations in an admirable narrative. It is possible that at this time Goethe might have grown discouraged and bitter were it not for

the friendship formed with Schiller in 1794. This friendship and its fruits fill the memorable years from that date to 1805, the year of Schiller's death. Together they worked in the "*Horen*," a review designed to elevate the literary standard in Germany. Together in the *Xenien* (1796) they discharged their epigrams against their foes, the literary Philistines. Schiller's sympathy encouraged Goethe to set to work once more on *Wilhelm Meisters Lehrjahre*, a novel which more than any other work of Goethe may be said to exhibit his criticism on life. In 1810 he published his two volumes on light and color, *Zur Farbenlehre*, already referred to, and these were speedily followed by the first part of his autobiography, *Dichtung und Wahrheit*, the continuation of which occupied him from time to time during several subsequent years. A grief, real and deep, came to Goethe in his sixty-seventh year, in the death of his wife. In his later years Goethe still continued active. From time to time during more than half his life he had worked at the second part of *Faust;* it occupied him much during the closing years, and was completed in 1831. Goethe died in 1832 after a short illness, and his body lies near that of Schiller in the ducal vault at Weimar. Goethe was a man of noble bodily presence, both in youth and age. His influence has affected every civilized people. His teaching has been styled the creed of culture; it is rather the creed of self-development with a view to usefulness.—(C. P. S.)

Goggle-eyed. Having prominent, staring, or rolling eyes; also employed by the vulgar as a synonym of exophthalmus and of strabismus.

Goggles. A pair of plain or colored glasses worn like spectacles, fixed in short tubes of wire gauze spreading at the base over the eyes, for their protection from cold, dust, sparks, etc., or from too great intensity of light, or so contrived with holes or slits as to direct the eyes straight forward, in order to cure squinting. Also contrived for horses that are apt to take fright. See **Eye-shades**; also, **Eye protectors.**

Goitre, Exophthalmic. See **Basedow's disease**; as well as **Exophthalmic goitre.**

Goitre exophthalmique variqueux. (F.) Exophthalmic goitre with numerous varicose veins crossing the surface of the tumor.

Gold and sodium chloride. CHLORIDE OF GOLD. See **Auri et sodii chloridum.**

Gold carbolate. This agent, of slight ophthalmic interest, has been recommended by Galezowski in one per cent. solution as a cautery for corneal ulcers in place of lactic acid.

Gold chloride. AURIC CHLORIDE. GOLD TRICHLORIDE. $Au\,Cl_3+HCl+$

HH_2O. This salt appears as yellow crystals, soluble in water and alcohol, and contains about 49 per cent. of pure gold.

The great expense and untried characters of gold salts make it unlikely that any of them will ever be used to any great extent in ophthalmic practice. However, a report of Verhoeff (*Journal American Medical Association*, 1906) is worth a short notice. By dissolving 1 grm. (gr. 15) of chloride of gold in 50 cc. (f. oz. 1 2-3) of water, and adding enough 5 per cent. aqueous caustic soda solution to make the reaction faintly alkaline, a fluid is obtained of very powerful bactercidal action; it is used as a collyrium with 50 cc. (f. oz. 1 2-3) of normal saline solution and 100 cc. (f. oz. 3 1-3) of a 1 per cent. solution of boric acid. This gold solution possesses great antiseptic and antifermentative power, and is said to possess the great additional advantage of being without irritant action on the conjunctiva. Again, no constitutional disturbance occurs as the result of introducing the proper quantity of the salt into the conjunctival sac. See, also, **Auri et sodii chloridum.**

Golden seal. See **Hydrastis.**

Goldhand. See **Abu Ruh. Muh. bin Mansur bin Abi Abdallah bin Mansur alyamani.**

Gold trichloride. See **Gold chloride.**

Golf-ball. Golf-ball accidents of the eye. Direct injury to the eye from the impact of the ball is not uncommon and the lesions resulting from this form of trauma do not much differ from those seen in injuries from similar blunt objects. On the other hand, certain so-called "fluid-core" or "water-core" balls, containing heavy, corrosive liquids, occasionally explode and burn the external eye.

An early example of this accident is reported by H. Maxwell Langdon (*Annals of Ophthalm.*, p. 171, Jan., 1913): It seems that while opening an English "Zodiac" golf ball, it suddenly exploded, the contents of the core being thrown in the patient's eyes. The right eye showed decided chemosis of the conjunctiva, and a general roughening of the corneal epithelium. The left eye had lost the epithelium from the lower third of the cornea, the remaining portion was rough, taking fluorescein stain, and the conjunctiva was so chemosed that the lids could not close. The cornea was quite hidden until the conjunctiva was pushed aside with a spatula.

He was placed in bed, and ice compresses and atropin were used; in twenty-four hours the chemosis was much less, and, on account of the condition of the corneæ and the large masses of subconjunctival exudate, heat was used instead of ice. The condition gradually improved, and in two weeks he was discharged, with a vision of 5/8 and

5/6 in O. D. and O. S., respectively. The last ten days he was on dionin, which hastened the absorption of the subconjunctival exudate very decidedly.

He has two small scars near the lower margin of the left cornea, and a small traumatic pterygium to the nasal side of the left cornea.

The core of the English Zodiac golf-ball is a small rubber bag filled with a grayish paste, which is strongly alkaline in reaction.

J. T. Carpenter and B. F. Baer, Jr. (*Annals of Ophth.*, p. 169, Jan., 1913) exhibited a patient, who, on August 4, 1912, received a severe burn of the left eye following an explosion of a "Zodiac" golf-ball, the core of which consists of a putty-like material possessing strong caustic properties.

The patient was first seen by Carpenter two hours after the accident, and presented the following condition: The left eyelids were swollen and reddened, the entire bulbar and palpebral conjunctiva transformed into gray, sloughing tissue, the cornea, except the upper fifth, opaque and milky, chemosis so great that the lids failed to cover the protruding conjunctiva. The vision was reduced to counting fingers. Treatment consisted of atropin, dionin, holocain, ice, and later hot compresses. At the end of two weeks there developed a severe iridocyclitis, with hypopyon and necrosis of the lower corneal quadrant.

Following the recession of the iridocyclitis a third stage of the process began—gradual failure of nutrition in the anterior ocular segment—the cornea being covered with superficial blebs, the episcleral tissues pale and cicatrized, and the corneal parenchyma so densely opaque that vision was only about 1/60. At this time, six weeks after the injury, subconjunctival salt injections were begun, a large quantity of normal salt solution being injected on every third day. The effect was so remarkable that but four injections were required. The eye which had shown no tendency to react to any treatment promptly responded to the salt injections, and remained quiet, the cornea so clear that vision with a plus 1.75 sphere is 6/6, the pupil widely dilated, and there is a complete absence of subjective symptoms.

W. O. Nance (*Jour. Ophth. and Oto-Laryn.*, November, 1912) describes a severe burn of the eye from an exploding fluid-core ball. The patient suffered intense pain in the eye and the skin surrounding the eye was burned in one direction for a distance of two inches. Examination demonstrated a deep opacity of the cornea in almost its entire area. In addition there was a cicatrized conjunctival area extending from the limbus for a distance of almost an inch to the inferior nasal aspect, at least one-quarter of an inch wide. The

remaining bulbar conjunctiva was swollen and red. Vision was reduced to mere perception of light. Tension was minus. Enucleation of the eye was advised.

The Editor (*Ophthal. Record*, Oct., 1912) has published a case of burn of the eyeball from the explosion of a water-core ball. Both the ocular and palpebral conjunctivas were swollen and hyperemic; in two situations there were subjunctival hemorrhages. There was marked ciliary and scleral congestion. About two-thirds of the cornea was covered by a thin, whitish eschar. The vision was restored to 6/12 minus.

Lowell (*Jour. Am. Med. Assocn.*, V. 61, p. 3202, 1913) observed six cases, of which three lost the use of one eye. There appear to be at least two different kinds of caustic put in the cores of these balls. Lowell had one mass analyzed by R. L. Emerson. It was found to contain a mixture of barium sulphate, soap and a free alkali. Balls of another make have been found to contain zinc chlorid in the solution. In view of the danger to the eyes of curious persons, mostly children, from such balls, a bill has been introduced into the legislature of Massachusetts to prohibit the sale. The United States Golf Association has also issued a warning against the dangerous practice of cutting open golf balls. See, also, **Injuries of the eye**; as well as **Conservation of vision**; and **Blindness, Prevention of.**

Golfe. (F.) A deep hollow; a sinus.

Golgi's method. A method of staining nerve-cells.

Gomenol. Oil of niaouli. This essential oil has been recommended as an application to the lids in trachoma by Dufaure (*La Clinique Ophtal.*, Vol. XVII, p. 472, 1911). It is derived from *Melaleuca veridiflora*, a Myrtacea found in New Caledonia, near Gomen. Dufaure advises this mixture: gomenol, 1.00; carbonate of guiacol, 0.30; camphor, 0.20; olive oil, washed and sterilized, 30.00.

As the changes which probably take place in this mixture give rise in time to pain-producing products, he finally decided on the following: gomenol, 1.00; oil of lemon, 0.25; olive oil, washed and sterilized, 30.00.

The oil of lemon is vaso-constrictive and highly bactericidal. With this mixture he has had comparatively great success, and he claims that with the help of a collyrium of zinc sulphate, it will bring about a condition that resembles a cure, if, indeed, it does not effect a cure, in a greater percentage of cases than by any other known remedy. Its virtue lies, furthermore, in the fact that it does not cause atrophy of the conjunctiva. Nor is its use limited to cases of trachoma; it acts as an excellent prophylactic in contagious eye diseases, no matter what

their etiology. In one case of complete xerosis of both eyes repeated instillations of gomenol afforded the previously blind patient sufficient sight to return to his home unaided.

Dufaure warns against the use of his remedy in parenchymatous keratitis during the inflammatory stages, and also during acute pannus.

Gomme. (F.) Gum.

Gomme de la conjonctive. (F.) Gummatous conjunctivitis; gumma of the conjunctiva.

Gommite. (F.) A mucilaginous gum; a term for all gummy substances.

Gondole. (F.) Eye-cup for eye douches.

Gondret, Louis François. A French ophthalmologic charlatan. Born at Auteuil, near Paris, July 12, 1776, he received his medical degree at Paris in 1803. He was physician at the Third Dispensary of the Philanthropic Society, Physician to the Court of First Instance, etc. He advertised extensively a derivative salve of his pretended invention, called by various names, such as "pommade ou graisse ammoniacale," "caustique ammoniacal," and "liparole ammoniacal." This he pretended would (among other wonderful effects) cure cataract without operation. He died in September, 1855.

Gondret wrote: 1. Observations d'Amaurose (Paris, 1821). 2. Observations sur les Maladies des Yeux (Paris, 1823). 3. Des Effets de la Dérivation et 2° Appendice à mes Observations sur les Affections Cérébro-Oculaires (1832; 2 ed., 1833). 4. Du Traitement de la Cataracte sans Opération (1839).—(T. H. S.)

Gonelli, Giovanni. Also called Gambasius and Gambasio. A blind Italian sculptor, of considerable merit. He was born in Tuscany in 1610, and died in 1664. He lost his sight at the age of twenty, and, ten years later, was suddenly seized with a desire to become a sculptor. Besides ideal images, he carved a number of portraits, the most remarkable of which is that of Pope Urban VIII.—(T. H. S.)

Gonflement. (F.) Swelling; tumefaction.

Goniometer. Angulometer. An apparatus for measuring solid angles: especially one for measuring the angles formed by the faces of prisms and of crystals.

Goniometric. Relating to the measurement of angles.

Goniometric function. The value of an angle of a prism or crystal expressed by a line of suitable length relative to an assumed radius, such as the sine, tangent, etc.; a trigoniometric function.

Goniometry. The art of measuring solid angles.

Gonoblennorrhea. The purulent discharge (from the eyes) due to infection from the gonococcus.

Herreschwand, of Innsbruck (Graefe's *Archiv. für Ophthal.*, Vol. 82, Part 2) finds that airol (bismuthoxyiodidegallate containing 24.8 per cent. iodin) added to the culture medium in 1/10,000 concentration, completely checked the development of the gonococci. In contrast to the silver salts, the antiseptic action of the drug is enhanced by sodium chlorid and albuminous bodies. Under these conditions a concentration of 1/1,000 suffices to kill the gonococci within half an hour.

The germicidal action is attributable in part to the desiccating action of the bismuth and to the astringent action of the gallic acid, but above all to the liberation of free iodin.

While the silver salts impair phagocytosis, airol brings about increased phagocytic activity.

Gonococcus. (G.) The specific organism of gonorrhea. See **Bacteriology of the eye.**

Gonococcus conjunctivitis. OPHTHALMIA NEONATORUM. ADULT GONORRHEAL OPHTHALMIA. See **Gonorrhea, Ocular relations of.**

Gonocoque. (F.) Gonococcus.

Gonorrhea, Ocular relations of. The chief local manifestations of this disease have already been described under **Bacteriology of the eye**; **Blenorrhea neonatorum**; **Blindness, Prevention of**; **Conservation of vision**; as well as under such headings as **Conjunctivitis, Purulent,** and **Iritis, Gonorrheal,** in which the local infection is discussed, but, as yet, little has been said of the general disease or of the systemic relations of the ophthalmic lesions set up by it. It is proposed here to discuss this last subject in particular.

Diagnosis of systemic gonorrhea. Apart from a microscopical and cultural examination of such discharges and of such tissues as are available for the purpose, the Bordet-Gengou or "complement-fixation" test seems most valuable. J. J. Ower (*Canadian Med. Journ.*, p. 1074, 1914) describes this reaction as depending on the following factors: (1) Complement, a substance present in all blood sera and destroyed by heat at 56° C.; (2) Amboceptor, a substance present in the blood serum of an animal which has been immunized against (3) some foreign protein, in this case red blood cells of an animal of a different species. If two sera containing certain definite proportions of these two substances are placed together in the presence of the red blood cells of an animal of one species which have been used to immunize another animal of a different species in the preparation of the amboceptor, the result will be a destruction of these red cells—

hemolysis. It is upon this hemolysis that the complement fixation test depends.

It is known, however, that under certain conditions the presence of two other substances will inhibit this hemolysis. These are (4) "antigen" and (5) antibody. Antibodies comprise certain substances formed in the blood serum of individuals suffering from a given disease, and are produced as the result of the specific infecting agent. The antigens for these antibodies are, strictly speaking, all substances (of proteid nature) which when introduced into an animal excite the production of antibodies. By confusion of ideas the name today is also applied to substances which have some of the chemical characteristics of the organism or agent causing any particular disease. Thus we speak of heart or liver extract as a syphilitic antigen; it having been found that these can replace the syphilitic virus in the Wassermann reaction.

If antigen and blood serum containing its specific antibody are added to complement, and these added to amboceptor and red blood cells, then the antibody and antigen combine with complement in such a way as to destroy its power to unite with amboceptor to cause hemolysis. This union of the antigen and antibody with complement with the resulting inhibition of its power to destroy red blood cells is called fixation or deviation of complement, and when present in a test in which a suspected serum is used instead of a known antibody, constitutes a positive reaction.

This is a somewhat brief explanation of the conditions required for this phenomenon. Each step requires scrupulously careful preparation. It has been found by experiment that fresh guinea-pig serum best fulfills the requirements of a complement. Blood serum of a rabbit which has been immunized against sheep red blood cells by repeated intravenous injections of small quantities of fresh sheep red blood cells constitutes or, more accurately, contains one of the best amboceptors. Sheep red blood cells must of course be used in the complement fixation test with a sheep blood amboceptor because the action of the latter is specific. Antigen varies with the disease in question, but is usually an extract of the organism which causes the disease. The antibody is of course the unknown, and a positive complement fixation test proves its presence in the serum of the suspected individual and therefore the presence of the suspected disease in the individual.

In summing up the results of our experience it may be said that the claims of recent investigators on behalf of the test seem to be justified. The test is specific and a positive reaction with a proper technique

indicates the presence of a gonorrheal lesion. On the other hand, negative results are not so valuable, as many sera from cases which are undoubtedly gonorrheal give negative complement fixation tests, as, for example, in acute urethritis, where the reaction is practically always negative.

An analysis of the cases seems to show that the best results are obtained where the lesions occupy sites where there is possibly a lack of free drainage. This is borne out by the high percentage of positive results in arthritis, salpingitis and prostato-vesiculitis. These are the very cases in which diagnosis is often extremely difficult and it is just in these cases that the test is of most value in indicating the line of treatment to be followed. As a positive reaction undoubtedly means the presence of an active focus of gonococci, its presence in a clinically cured case of gonorrhea would necessitate further careful examination of the case.

E. E. Irons (*Annals of Ophthalm.*, p. 771, Oct., 1913) states that in addition to the complement-fixation test we have, as in tuberculous infections, a general reaction which can be elicited by the introduction of comparatively large doses of toxic material from gonococcal cultures. These give rise to malaise, headache and a certain local reaction at the site of the injection, together with a focal reaction in the affected part. Such reactions are not constant in gonococcus infections, but occur with sufficient frequency to be of some value in diagnosis. Then there is the local subcutaneous reaction which may be obtained by a smaller dose subcutaneously. A small dose in a normal individual will produce little or no reaction; in an infected individual a more extensive reaction. This line of diagnostic work has been followed out pretty carefully in the German clinics in the pelvic affections of women and has been found to be of considerable value, as confirmed by operation.

Then there is the cutaneous reaction which can be demonstrated as in tuberculosis after the method of von Pirquet. While there are certain disadvantages which rather decrease the value of this method as a single diagnostic agent, still there are certain advantages in the study of the patient by the cutaneous reaction in the use of glycerin cultures of the gonococcus, and by repeated tests we can determine that the immunity curve is not constant but goes up and down, and that the exacerbations of joint lesions and the temperature are coincident or follow shortly after a period of low cutaneous reactivity.

Another method by which we can identify rather obscure cases of gonococcal infection is the cultural method of the various secretions, particularly those of the prostate. Although it is rather not the rule

in urethral infections, the prostate may remain infected for a long time, and certain metastatic manifestations in the joints are merely expressions of metastasis of the organisms passed into the blood stream and lodged in certain vulnerable spots. So that in cases in which the etiologic factor is not evident we may apply these four tests and in a certain proportion obtain positive results in cases due to gonococcal infection.

W. G. M. Byers (*Studies from the Royal Victoria Hospital, Montreal,* Vol. II, No. 2, 1908) concludes that *systemic* gonorrhea most commonly occurs in males, but nothing definite is known as to the factors which underlie the undoubted predisposition of certain individuals to this form of the disease. Pathological evidence seems to show that the gonococci themselves and not their free toxines, or the secondary or mixed infections, are responsible for the local manifestations. Metastatic inflammations of the eye, of gonorrheal origin, are marked, in general, by uncertainty and irregularity as regards their time of occurrence, the severity of their symptoms and their course and behavior; by their close association with metastases of like origin in other parts; and by a marked tendency to relapse and to recur. Ocular inflammations are often the first manifestation of systemic gonorrhea, and there is reason to believe they are sometimes the sole expression of this condition.

Metastatic gonorrheal conjunctivitis is a well-established clinical entity. It occurs at any time during systemic gonorrhea, and usually involves both eyes simultaneously. In 30 per cent. of the cases the inflammation is complicated by affections of other coats of the eye.

The *keratitis* which occurs in association with systemic gonorrhea is of a multiple and superficial character and commonly symmetrical, and central in situation.

Cases of gonorrheal *sclero-conjunctivitis* ought to be differentiated from metastatic conjunctivitis and classed by themselves.

In every case of *gonorrheal iritis* the pathological process is not limited to the iris. It is probably advisable to discard the term iritis for that of irido-cyclitis.

Metastatic gonorrheal affections of the uveal tract show a tendency to be bilateral in the first, as compared with second and later attacks, and to relapse and to recur with fresh gonorrheas. They precede, follow or accompany other manifestations, or form the sole expression of the systemic infection; but they are marked by no special features except that swellings of any kind in the iris tissue are never observed. Gelatinous exudations are more indicative of the severity than of the origin of the inflammation.

The *metastatic gonorrheal inflammations of the optic nerve and retina* commonly take the form of a diffuse neuro-retinitis, associated at times with considerable retinal edema. Pathological evidence favors the blood vessels rather than the lymph spaces as the principal route for infection.

The cases of *dacryo-adenitis,* which have been attributed to systemic gonorrheal infection, conform to what is known of inflammation of the lachrymal gland in general, viz., that while cases caused by direct extension are generally unilateral and go on to suppuration, those produced by metastasis are usually bilateral and end in resolution.

Herrfordt (Graefe's *Archiv. f. Ophthalm.*, 72, 2, 1909) observed 23 cases of "endogenous" conjunctivitis in 2,310 patients affected by gonorrhea—just one per cent. The proportion was smaller in women than men, and relatively larger in cases of recurrent or chronic gonorrhea. It was associated relatively often with arthritis. Gonococci were only very exceptionally found in the conjunctival secretion. Compared with the ordinary or "exogenous" form these cases run a mild course and are easy to cure though apt to relapse so long as the gonorrhea lasts. The inflammation affects the bulbar more than the palpebral conjunctiva, is usually bilateral and may be either diffuse with much superficial injection or localized with deeper episcleral injection. It is very apt to take the form of a phlyctenular conjunctivitis and in these cases the cornea may become affected as in phlyctenular keratitis.

The treatment recommended for cases without secretion is daily massage with yellow ointment, for cases with secretion copper sulphate solution 1/4 per cent. As the cases are rare, their cause may easily be overlooked and the important thing is to remember that an uncured gonorrhea is liable to produce this among other ill effects.

There are, according to McKee, of Montreal, at least three theories of the origin of metastatic gonorrheal conjunctivitis, viz.: that it is due to gonotoxin, to the toxin to which the organism gives rise and not to the organism itself; that the original infection is a mixed one and that the conjunctivitis is caused by one of the organisms other than the gonococcus; and that it is a true metastatic infection, the gonococcus being carried by blood-vessels or otherwise from urethra to conjunctiva. McKee believes that he has been able to settle the matter and prove the metastatic theory to be true by finding the organism in the conjunctival secretion. The case which afforded him his material was in most respects a typical one—the recent gonorrhea, the sudden onset in both eyes at once of a muco-purulent conjunctivitis, the absence of any serious involvement of the cornea, the marked tendency

to recurrence, the simultaneous development of joint involvement—all were recorded in this instance. The chief point lies in the success—all the more noteworthy because numerous good observers have failed—of the endeavor to determine the presence of gonococci in the conjunctival secretion. This was attended with great difficulty and necessitated enormous patience on the part of the observer. For example, at the first visit of the patient, McKee made and exhaustively examined eighteen slides unsuccessfully before he found one in which there were at one part a very few organisms resembling gonococci lying in leucocytes. Growth on hemoglobin agar (after failure with other media) showed a development after some time which consisted almost entirely of xerosis bacillus, but in it were a few small areas of different aspect from which the desired organism was obtained and gradually isolated in pure culture. This was by several tests distinguished from micrococcus catarrhalis (nose), from meningococcus, a urethral micrococcus, and saprophytic Gram-negative diplococcus. The observer failed to discover any organisms in a morsel of tissue cut from the conjunctiva during the stage of inflammation.—(*Ophthalmology*, July, 1909.)

Sidler-Hugenin (*Archives of Ophthalm.*, July, 1912) reviews twelve cases of metastatic ocular disease. Of these, five had a severe, and four a mild unilateral metastatic irido-cyclitis, and three a bilateral metastatic conjunctivitis. In five cases gonococci were demonstrated in the blood, whereas, from the anterior chamber of six patients with irido-cyclitis, gonococci were cultivated only once. In this particular case the disease was of exceptional severity.

In order to cultivate gonococci from the blood or anterior chamber, the author advises examination during the time of highest temperature, as it appears likely that in the afebrile period, or when there is very little increased temperature, the gonococci do not circulate in the blood. He recommends the use of as large a quantity of material as possible.

In an addendum he gives two cases, one of his own and one of Haab's, in both of which a metastatic abscess formed in the lid, and though this burst and flooded the conjunctival sac with gonococci, no general conjunctivitis followed. This the author suggests may have been due to the prophylactic use of silver nitrate, but it seems not unlikely that these particular organisms may have undergone a considerable alteration in their virulence.

In classifying a corneal involvement as *endogenous keratitis gonorrhoica* the following requirements must, according to F. Pincus (*Arch. f. Ophthal.*, March, 1914) be present: First, the presence of gonococci in the urethral or vaginal discharge at the time of onset of the keratitis. Second, the keratitis must not be the only manifestation of a

systemic infection, but either preceding or following the keratitis there must be some other form of gonorrheal metastasis. Third, the conjunctival secretion, if present, must be negative as to gonococci. Fourth, we must exclude the presence of a scrofulosis, occurring with a gonorrhea, which might be the cause of the keratitis. The author does not believe that a well-defined clinical picture can be described.

Finally, it must not be forgotten that if a primary urethral or vaginal gonorrheal infection may poison the whole system, including the eye, infection of the whole organism from toxins of ocular origin may (though rarely) also occur. Sydney Stephenson (*Ophthal. Record,* Sept., 1906) believes it to be more common than is generally supposed. He reports a curious example of general sepsis following probable gonorrheal ophthalmia. It was a case of antepartum ophthalmia in which the gonococci could not be found. Both corneæ perforated. One month after birth the child developed multiple abscesses, one on the foot, the arm and the hand. They were opened but no gonococci found. At no time did the temperature go above normal. The child recovered.

Treatment of endogenous ocular gonorrhea. The conduct of systemic gonorrhea, including the primary infection, really belongs to the domain of the general practitioner, yet the ophthalmologist should keep himself informed as to the best means of combating the disease. Perhaps the most effective treatment of the general toxemia is *seropathy* (q. v.). For example, Harrison Butler (*Ophthalmoscope,* Dec., 1911) reports three cases of gonorrheal iritis which were treated with antigonococcal serum. All cases had resisted the ordinary forms of treatment, such as atropin, hot fomentations, sodium salicylate, etc., and showed marked improvement after injection of the serum.

In one case, two injections (2 cc. each) of the Parke-Davis antigonococcal serum were followed by rapid, complete recovery.

In a second case, the first two injections had a pronounced effect upon the disease, but it did not appear to be lasting, for the left eye relapsed slightly and the right became inflamed. The last injection acted like a charm, the right pupil, which before would not dilate, within twenty-four hours of the injection became fully dilated and the iritis rapidly lost its acute character. The second injection caused slight symptoms of serum disease, urticaria and some irritation of the skin.

In the third case, one injection was followed by a disappearance of symptoms. Antigonococcal serum being made from ram's blood seems to be more likely to cause serum disease than the ordinary horse serum, and it is better to give both injections within a short interval and not to repeat the dose more than once.

Arnold Knapp (*Arch. of Ophthal.*, March, p. 235, 1908) reports the results of treatment of a single case of gonorrheal iritis with Torrey's serum. The patient contracted the disease two and one-half years before, and had suffered from inflammation of the ankle, knee, hip, and pericardium. He had three attacks of iritis; and in the last two —one in each eye—received injections of Torrey's antigonococcic serum. The first injections aggravated the ocular symptoms, and one of them was followed by fever, but afterwards the eyes cleared up very rapidly. Ten injections were given in each attack.

Reber and Lawrence (*Ophthalmic Record*, March, 1915) report three cases of iritis as a manifestation of an old, latent gonococcemia. In each instance the etiologic diagnosis was not entirely rested upon the clinical findings, which may often be misleading, but was firmly established on a scientific basis by the use of the complement-fixation test for Neisser's organism. The subsequent treatment with bacterins and serums was followed by results prompt and gratifying.

Gonorrhoïsche Bindehautentzündung. (G.) Gonorrheal conjunctivitis.

Gonzales y Morillas, Don José Maria. A pathologist and ophthalmologist of Havana, whose life dates are unknown. He wrote: "*Monografía Oftalmológica ó Descripcion de Todas las Enfermedades que Pueden Padecer los Organos de la Vision y Partes Anexas* (2 vols., Habana, 1848-50).—(T. H. S.)

Goodland, William. An English surgeon of the early 19th century, who practised at Bolsaver, Derbyshire, and Bury, Lancashire. He wrote "*Observations on Purulent Ophthalmia*" (1810).—(T. H. S.)

Goose, The. The gall and the fat of the goose were both employed as medicaments in ancient Greco-Roman ophthalmology. Thus, according to Pliny, the gall was good for contusions. The fat was used for a menstruum, in the manufacture of eye salves, and was also thought to possess considerable value as an ocular anesthetic. An especial reputation as an ocular "pain-killer" was had for many centuries by the salve called "commagenum." To produce this valuable article, the grease of the goose was mixed with cinnamon, cassia, white pepper and valeriana scabiosaefolia in a vessel cooled with snow.—(T. H. S.)

Gordon, Bernard de. A French physician of Scotch descent, who received his medical education at the school of Salerno, Italy. The dates of his birth and death are not known. He taught, however, at Montpelier, from 1285 to 1307. He wrote in 1302 (1303?-5?) a work entitled "*Lilium Medicina*" (Lily of Medicine). This is a kind of medical encyclopedia, including as it does the entire pathology of the human system. In 1377 it was translated into French under the title, "*La Pratique de Tres Excellent Docteur et Maistre en Médicine,*

Bernard de Gordon, qui l'Appelle Fleur de Lye en Médicine." The ocular portion of the "*Lilium*" includes no surgery at all. Whenever a surgical matter requires mentioning, Bernardus simply refers us to a "chirurgus literatus et expertus." However, the ocular portion of the "*Lilium*" is quite an interesting affair. First, it treats of ocular anatomy and physiology, then, in successive chapters, the diseases of the conjunctiva, the cornea, the uvea, those of the eye throughout its entirety, and, finally, those of the lids.

What he says, in chapter 1, about the nature of vision possesses an especial historical value. "The animal spirit called the visual, descends by the optic nerves to the eye, where it spreads to the crystalline humor, and then to the interior surface of the eye; it receives there the image of the object, which has been brought [i. e., from without] to the crystalline, in which situation is produced the first modification of colors *(mutatio colorum)*; then it carries the representation of the object *(simulacrum)* as far as to the common sense [intelligence]."

Bernard is said to have been the first medical writer to mention the use of spectacles. Of course, the word "medical," in this connection, should be well emphasized. (Roger Bacon it was who, in his "*Opus Majus*,"—almost fifty years earlier than Gordon's "*Lilium*"—first records—so far at least as history shows—the value of convex lenses for those who are old- or weak-of-sight.) Gordon, moreover, adds that he knows of a collyrium which renders spectacles unnecessary. His words on this head are indeed of so great historical importance that I append them here as they stand in the original Latin: "Hoc collyrium est tantæ virtutis quod decrepitum faceret legere litteras minutas sine ocularibus." So the printed editions run. True and Pansier, however, inform us that, in the manuscripts, the expression employed by Bernardus was not "oculare," but "oculus verrelinus" or "oculus berillinus"—i. e., "eye of glass," or "eye of beryl."—(T. H. S.)

Gorge. (F.) Throat; neck; gullet.

Gorgon. The early Greek, in his ritual, had a hideous mask—the Gorgoneion. This he employed to scare away evil things, both enemies and ghosts. Concerning this (mask) head, in the course of time, there grew up a considerable mythology. Poets said that the Gorgoneion was the head of a certain unspeakable monster, a Gorgon. Homer declares, for example, that the Gorgon's head is one of the terrors of Hades, also that it forms the center, or boss, of the shield of Jove. Hesiod has three Gorgons: Stheno (*Valeria*, the mighty), Euryalé (*Lativolva*, the wide-wandering) and Medusa (*Guberna*, the

ruler). They are daughters of the sea-god Phorcys by his sister Ceto, and sisters of the Graiæ (q. v.). They have snakes for girdles and hair, and the glance of an eye of any one of them turns the beholder immediately to stone. See **Basilisk, Cockatrice,** and **Vathek.**

Perseus, on account of a promise rashly given to Polydectes, made an expedition against Medusa, the only one of the Gorgons who was mortal. First, he stole the eye and tooth of the Graiæ (or Phorcydes) and these he would not return until these sisters of the Gorgons had informed him how to procure of certain nymphs the winged shoes, the magic wallet and the helmet of Pluto, which made the wearer invisible. Having acquired and donned these articles, he took the sword (Harpá) which Hermes had given him, and flew to the place where the Gorgons lay asleep. To keep from being turned to stone, he looked at the head of Medusa as this was reflected in his shield, and so, guided by Athene, he smote the horrible head from its owner's shoulders.—(T. H. S.)

Gorre. (F.) An old name for syphilis.

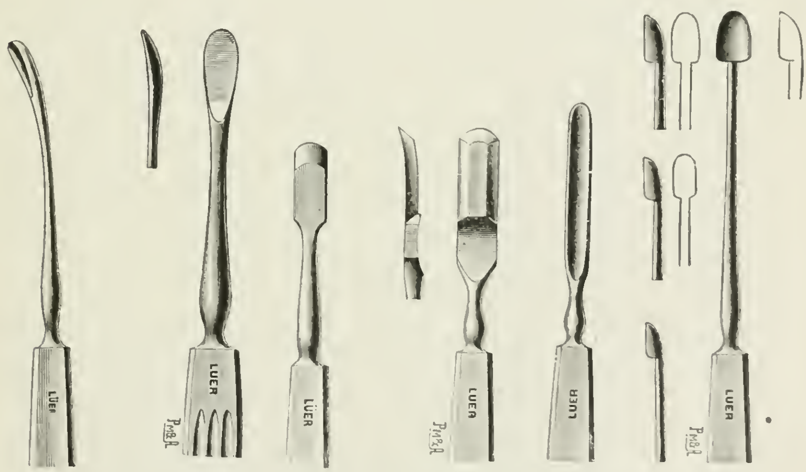
Gossypium acidi borici. Borated cotton. A preparation of the London Throat Hospital containing 50 per cent. of boric acid.

Gotta serena. (It.) "Drop serene." Amaurosis.

Gouêtre. (F.) Goitre.

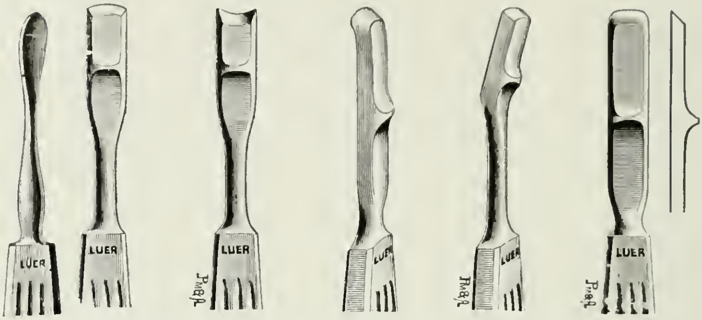
Gouge pour corps étrangers. (F.) Spud for the removal of foreign bodies.

Gouges, Ophthalmic. These instruments are employed for the removal of bone and for enlarging openings and cavities in bony tissue. They



Gouges and Raspatories for Removing Bone and in Making Lachrymal Sac Openings.

are made of many shapes and sizes, albeit more delicate and smaller than the majority of corresponding instruments used in general surgery. See the figures.



Gouges and Raspatories for Removing Bone and in Making Lachrymal Sac Openings.

Gough, John. A celebrated blind instructor of sighted pupils. He was born at Kendal, Westmoreland, England, and at the age of two was completely blinded by smallpox. When six years old he was sent to the School of the Society of Friends, where he seems to have advanced more rapidly than any of his sighted companions. He afterwards studied mathematics under a private instructor, a Mr. John Slee.

He then became an instructor of sighted pupils, and, in this capacity, is said to have been "the greatest known example." Among the celebrated scholars who once were under his tutelage, were Dalton, Whewell, Gaskin, King and Daws.

Gough wrote numerous articles on the following subjects: botany, mechanics, statics, hydrostatics, pneumatics, acoustics, electricity, magnetism, zoology, music and scotography. These appeared, for the most part, in *Nicholson's Journal* and the *Memoirs of the Literary and Philosophical Society of Manchester.*

Gough died in 1825, aged 68, and was buried in Kendal churchyard.—(T. H. S.)

Gouging. The violent removal (enucleation) of an eye.

Goulard's extract. See **Lead water.**

Goulard, Thomas. A well-known French physician, surgeon and ophthalmologist, introducer of "Goulard's Extract," an aqueous solution of the subacetate of lead, and of "Goulard's Cerate," an ointment containing this extract. He was born at Saint-Nicholas-de-la-Grave, near Montauban, France, about 1724, and, at an early age, was appointed demonstrator royal of anatomy and surgery, as well as surgeon-major, at the Military Hospital in Montpellier. In 1740 he

became a Fellow of the Academy of Surgery. He seems to have been a man of strongly quackish tendencies. His subacetate solution, to which he gave the name of "Aqua Vegeto-Mineralis," he commended as a well-nigh infallible cure for almost every disease in the nosology, especially for those of the eye and the urethra.

His principal writings are as follows: 1. Mémoire sur les Maladies de l'Uretère et sur un Remède Spécifique pour les Guérir. (Montpellier, 1746.) 2. Lettre de M. Goulard, a M. de la Martinière sur les Bougies pour les Carnosités. (Montpellier, 1751.) 3. De la Composition des Bougies. (Montpellier, 1751.) 4. Traité des Maladies de l'Uretère, avec le Composition des Différentes Espèces de Bougies propres à les Guérir Radicalement. (Montpellier, 1752.) 5. Remarques et Observations Pratique sur les Maladies Vénériennes, etc. (Montpellier and Pézénas, 1760.) 6. Traité sur les Effets des Préparations de Plomb, et Principalement de l'Extrait de Saturne, Employé sous Différentes Formes, et pour Différentes Maladies Chirurgucales. (Montpellier, 1760; Eng. Trans., London, 1769 and 1775.) 7. Oeuvres de Chirurgie. (2 vols., Paris, 1763 and 1767; Liège, 1779.)

Goulard also invented a number of surgical instruments. In 1772 he became blind, and, in 1784, he died.—(T. H. S.)

Goût. (F.) Taste.

Gout, Ocular relations of. Gouty eye. It is the belief of Parsons (*Pathology of the Eye*, p. 1310) that the role of gouty affections in eye diseases is either difficult or impossible to determine. That the diathesis is the cause of some of these conditions can scarcely be doubted, but it is still more probable that many are due to intercurrent disease and are modified by the constitutional disorder. In the present unsatisfactory state of knowledge as to the pathology of gout the ocular conditions which arise can only be enumerated. Amongst them are [in particular, *glaucoma* and *episcleritis periodica fugax*] eczema, tophi, hyperemia, and edema of the lids, conjunctivitis, scleritis, sclerosing keratitis, band-shaped opacity, iritis, cyclitis, and choroiditis, punctate opacities in the lens, recurrent vitreous hemorrhages, with detachment of retina, or retinitis proliferans, retinal hemorrhages, retinitis punctata albescens, papillitis and retrobulbar optic neuritis.

Each of these ocular affections will be found fully described under appropriate headings.

Bull (*Ophth. Year-Book*, p. 66, 1909) says the deep lesions of the eye associated with gout seem to be increasing in frequency, and are very destructive of vision. They are seen in patients past middle age, markedly gouty, who lead a sedentary life. Advanced cardio-

vascular changes are always present. The ocular inflammation he has not seen simultaneous with an arthritic attack, but always associated with an intestinal attack; and the urine always showed excess of uric acid and indican. Intraocular hemorrhages occur early in the disease, but are less frequent later. The treatment must modify habits of life, diet and exercise. A moderate use of alcohol, well-diluted, is less dangerous than the use of tobacco. In giving vaso-dilators, Bull regards the sensations of the patient as an important guide. Somewhat related to the condition Bull describes are the ocular lesions of alimentary constitutional origin, reported by Heilbron. He has met two cases of severe irido-cyclitis preceded by vomiting, chill, fever, and in one case palpitation of the heart and unconsciousness. See, also, **Glaucoma**; and **General diseases.**

Goutte. (F.) Drop (of a liquid); also, the gout.

Goutte sérène. (F.) Drop serene. Amaurosis.

Gouttière. (F.) Gutter; groove.

Gouttière lacrymale. (F.) Lachrymal groove.

Gower, Sir John. A famous English poet, who was blind in the latter portion of his life. He was born in 1325, and was therefore a contemporary of Chaucer. He was a man of great learning, and was patronized by both Richard II and Henry IV. He wrote in Latin, French and English. His best known works are, in French, *"Speculum Meditantis;"* in Latin, *"Vox Clamantis;"* and, in English, *"Confessio Amantis."* In 1397 he married Agnes Groundolf. Very shortly afterward, he became blind. His declining years were spent in the Priory of St. Saviour's, Southwark. There he died in 1408; there, too, he was buried; and there now stands his monument.—(T. H. S.)

Gowers' pupil. This sign is occasionally seen in tabes dorsalis. It consists of intermittent and abrupt oscillations of the iris under the influence of light, and is found mostly before the total loss of the light reflex.

Grab backs. See end of heading **Eyeglasses and spectacles, History of.**

Grab fronts. Lenses attachable, usually by hooks, to the anterior surface of permanently worn glasses for the purpose of increasing temporarily their refractive effect.

Gracillimus oculi. (L.) GRACILLIMUS ORBITÆ. COMES OBLIQUI SUPERIORIS. An anomalous accessory superior oblique muscle of the eye, resulting from the separation of the muscle into two parts.

Gradatim. (L.) By degrees; step by step.

Gradation of tone. The gradual merging of one tint or color into another.

Gradenigo, Count Pietro de. A famous Italian ophthalmologist. He was born at Venice in 1831, and in his native city received his preliminary education. When seventeen years of age he served with distinction as a volunteer in the uprising against Austria. He studied medicine at Padua, receiving his medical degree from that institution in 1855. He was soon appointed assistant in the Ophthalmic Clinic in the same city, and, in 1858, surgeon to the Venice Hospital. The latter position he resigned in 1868, and in 1873 was appointed to the full professorship in ophthalmology in the University of Padua. He died Dec. 1, 1904.

Gradenigo is said to have introduced the ophthalmoscope into Italy. He certainly invented a special form of the clinical thermometer and of the stethoscope, both of which have been found very useful. He wrote a large number of articles on ophthalmologic subjects; chiefly ocular antisepsis, corneal opacities, the extraction of cataract, and digital massage in various diseases of the eye. His numerous contributions were published in volume form in 1904 by two of his pupils, Ovio and Bonamico.—(T. H. S.)

Gradenigo's syndrome. Paralysis of the abducens during the course of an acute or chronic otitis. See **Ear and eye, Relations of the.**

Gradle, Henry. A celebrated ophthalmologist of Chicago, author of the first work in English on the "*Germ Theory.*" He was born at Frankfort-on-the-Main, Germany, August 17, 1855. His medical degree was received at the Chicago Medical College in 1874. After an interneship at Mercy Hospital, Chicago, he studied in Vienna, Heidelberg, Leipsic, Paris and London. He was professor of Physiology in the Chicago Medical College from 1881 till 1895; and Professor of Ophthalmology and Oto-Laryngology in the same institution from 1895 to 1906. He was a member of the Chicago Medical Society, the Chicago Ophthalmological Society (of which he was once President), the American Medical Association, and the Heidelberger Ophthalmologische Gesellschaft. He wrote, as stated, the first work in English on the "*Germ Theory,*" and also a "*Textbook on the Nose, Pharynx and Ear.*" He also contributed numerous articles to American and German periodicals. As an operator, he was unexcelled.

Dr. Gradle was a man of unique personality. "The Little Giant," Dr. G. Frank Lydston called him. He was five feet one inch high, stockily built, and with a very large head. In early life his hair was black, curly, and abundant, but, as his years advanced, he became almost totally bald. His reddish mustache was never tamed, but wandered at will. He was wont to declare it "a virgin." His eyes were brown and usually very serious, though any incident that appealed to him aroused in them a merry twinkle.

He was a man of rugged constitution, and daily for over thirty years walked to and from his office—nearly two miles. Yielding to physical weakness was a fault he could never condone in others, as he himself was never known to complain.

Henry Gradle.

His manner with patients was brusque, and he did not attempt to ingratiate himself. But his worth soon revealed itself to them, and seldom if ever did his patients seek other sources of aid. He was a counsellor, and they came to him with their woes as well as with their ocular pathology.

His recreations were very few and simple. Chief of all was scientific reading, and this he indulged in nightly from 9:30 to 12, propped up in bed and smoking a cigar. Not alone ophthalmology, but general medicine, bacteriology, neurology and especially physiology and physiologic optics were among his favorite subjects. Helmholtz was his divinity, and he discovered passages in the great man's

writings that had been entirely overlooked by even trained physicists. His other recreations were: horseback-riding, sea-bathing, croquet and walking. Once a week he bowled with a few old friends.

He died at Santa Barbara, California, April 4, 1911, of carcinoma of the bladder, aged 55. His large collection of medical books was left to the John Crerar Library, at Chicago. He also left to the Crerar Library a fund, the yearly increment of which is devoted to the purchase of journals relating to the eye, ear, nose and throat.—(T. H. S.)

Graduated tenotomy. This operation (see, also, **Muscles, Ocular**) has been practised for many years, but the question of its value still remains a subject of dispute. The topographic relations existing between the muscles of the eyeball and the eyeball itself; the small result sometimes obtained from a complete division of a tendon; and the slight, at times negative, effect upon muscular anomalies even when the graduated operation has been repeatedly performed, all are calculated to inspire distrust in its efficacy.

In those exceptional cases where attention to the error of refraction, to the development of the ducting power of the muscles, and to the health of the patient fails to remove undoubted reflex symptoms, it will usually be found that there exists a latent phoria which finally, under prismatic correction of the manifest degree, becomes total and suited to a thorough surgical procedure.

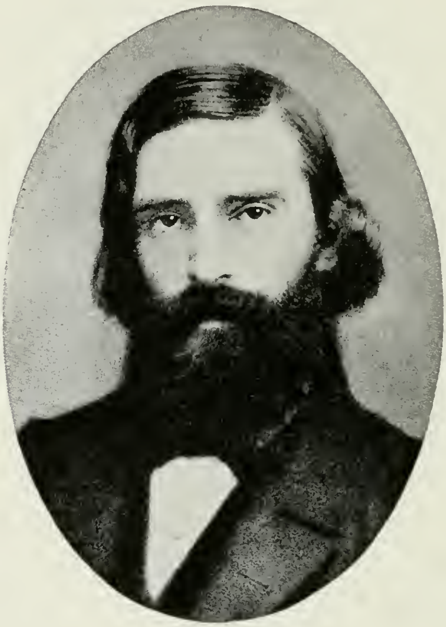
For this operation special instruments, more delicate in construction than those used for complete tenotomy, have been devised by Stevens. A small fold of conjunctiva, directly over the insertion of the tendon, is seized and snipped transversely so as to make a minute opening. Into this opening the forceps are introduced and a small fold of the tendon, immediately behind its insertion into the sclera, is grasped and snipped. One blade of the scissors is introduced into the opening thus made, and is slipped beneath the tendon, which is then snipped in the direction of one of its borders, to such an extent as may be deemed necessary. The scissors are then turned in the direction of the opposite border, and an equal extent of the tendon divided. The effect of the operation is then determined, and, if insufficient, more of the tendon is divided. This procedure is repeated until orthoporia is produced.—(J. M. B.)

Graduating diaphragm. Iris diaphragm. A diaphragm so arranged that it is capable of concentric enlargement and reduction of the aperture.

Graduction. Angular subdivision into degrees, etc.

Graefe, Albrecht von. One of the greatest ophthalmologists of all time, inventor of iridectomy for glaucoma and of the linear operation for

the extraction of cataract. Born at Berlin, Germany, May 22, 1828, the son of Carl Ferdinand von Graefe, he received his early education at the French Gymnasium in Berlin. He then entered upon the study of medicine in the Berlin University. All who knew him in his student days declared him to be a man of incomparable brilliancy. Aug. 21, 1847, he received his degree, presenting as dissertation "De Bromo ejusque Praeparatis." In 1848 he went to Prague, where



Albrecht von Graefe.

he came under the influence of Ferdinand Arlt, then in the zenith of ophthalmologic glory. To Arlt the thanks of the world are due for directing young von Graefe into ophthalmology as an exclusive life career. After parting with Arlt, von Graefe spent two years in Paris under Sichel and Desmarres. Then, for a time, he studied with Jaeger, Father and Son, in Vienna, and in London with the great Critchett and the still greater Bowman. In London a beautiful friendship sprang up between Bowman, Donders (of Utrecht) and the young von Graefe—a friendship on which was based an abundant three-cornered correspondence that endured till the death of the lamented von Graefe at the early age of 42. See **Bowman** and **Donders**.

In 1850 von Graefe returned to Berlin, being now an epitome of all the ophthalmology, theoretical and practical, that existed in his day. He began at once to practise, and was at once successful. In 1852 he became privat-docent in ophthalmology, presenting as his thesis "Ueber die Wirkung der Augenmuskeln." He was one of the first to employ the ophthalmoscope after its invention by von Helmholtz in 1851. He it was who revived and improved the strabismus operation, which had fallen into disuse. In 1854 he founded the "*Archiv für Ophthalmologie*," which marked an epoch in the development of ophthalmology. His investigations into the nature and extent of the visual field were followed by rich results. He was the first to show that "optic nerve paralysis" was, in fact, a result of inflammation of the optic nerve. He discovered the relation which exists between cerebral tumor and the so-called "choked disc." He was the first to recognize, ophthalmoscopically, the conditions resulting from embolism of the *arteria centralis retinæ*. His discoveries in connection with glaucoma were numerous and immensely important. In particular, the operation of iridectomy * as a means of treating glaucoma, has rendered him immortal. The modified linear extraction of cataract (1866) was also his invention.† For the performance of this operation von Graefe invented a straight and narrow knife, 2 to 3 mm. in width, which is still almost universally employed in cataract extraction, and still is known as the von Graefe, or, incorrectly, the Graefe, knife. The linear operation, however, is now very seldom employed. Its purpose was to obviate suppuration—a consummation still to be devoutly wished, but now secured (since the time of Lister) by means of strict asepsis.

Von Graefe's most important writings are as follows: "Beiträge zur Physiologie und Pathologie der Schiefen Augenmuskeln"; "Ueber Doppelsehen nach Schieloperationen und Incongruenz der Netzhäute"; "Ueber die Diphtherische Conjunctivitis und die Anwendung des Causticum bei Acuten Entzündungen"; "Ueber das Gesichtsfeld bei Amblyopie"; "Ueber die Iridectomie bei Iritis"; "Ueber den Werth Einseitiger Cataractextraction"; "Ueber Lineare Extraction";

* He did not, however, invent the procedure itself. The honor of so doing belongs to Beer, who, in 1795, both invented and employed this operation as a means of forming an artificial pupil, the Cheselden operation (1728) having been a mere iridotomy. Von Graefe, however, was the first to employ an iridectomy as a means of treating glaucoma.

† He was not the first to perform a combined cataract extraction—that is to say, to employ a preliminary iridectomy. The honor of having so done belongs to von Mooren of Düsseldorf (1864), but von Graefe was the first to do the *combined linear* operation.

"Schielen und Schieloperation"; "Ueber Morbus Basedowii"; "Die Iridectomie bei Glaucom"; "Ueber Embolie der Arteria Centralis Retinæ"; "Neuritis Optica nach Cerebralkrankheiten"; "Ueber Glaucom und Iridectomie"; "Ueber Calabar-Bohne"; "Ueber Muskuläre Asthenopie"; "Ueber die Modificirte Linearextraction"; "Beiträge zur Pathologie und Therapie des Glaucoms"; "Ueber die Operation des Dynamischen Auswärtsschielens, Besonders in Rücksicht auf Progressive Myopie."

Like his celebrated cousin, Alfred, Albrecht von Graefe was always of feeble health. This valetudinarianism was very much increased by his enormous activities—activities which, no doubt, were always somewhat over-stimulated by the presence at his clinics of great throngs of students and practitioners from every portion of the civilized world.

Von Graefe was a very charitable and kindly man. All his patients, rich and poor, high and low, were alike welcome. There was never the slightest discrimination. All were met with gentleness and courtesy.

Already in 1858 von Graefe was very much troubled by recurrent hemoptysis and pleurisy. He continued to work, however, until he died—July 20, 1870. At the time of his death he was still a young man, being only 42 years of age. No doubt his demise was hastened by his long-continued overwork. After all, however, the value of a life cannot be measured in mere years; and, measured in kindliness and courtesy, in stingless charity and unhesitating sacrifice of self, Albrecht von Graefe's mundane existence had been of almost infinite duration.—(T. H. S.)

Graefe, Alfred Carl. Cousin of the more distinguished ophthalmologist, Albrecht von Graefe, and nephew of that distinguished inventor in the field of general plastic surgery, Carl Ferdinand von Graefe. Born Nov. 23, 1830, in the castle of his grandfather, Martinskirchen, near Mühlberg a. d. Elbe, he studied from 1850 to 1854 at the universities of Halle, Heidelberg, Würzburg and Leipsiz. His medical degree was received at Halle in 1854, presenting as dissertation "De Canaliculorum Lachrymalium Natura." From 1855-58 he served as assistant to his cousin, the world-renowned Albrecht von Graefe. The cousins were nearly of the same age (Alfred being the younger by only two years) and, until the death of Albrecht at the early age of 42, were fast friends.

In 1858 Alfred became privat-docent in ophthalmology at Halle, and in the same year founded the "Klinik für Augenkranke"—at first a private, but later a public, institution. The attendance at this

hospital was enormous, as was properly the case when the founder and surgeon-in-chief of the institution held a record of 400 cataract extractions without the loss of one single eye.*

In 1864 Graefe became *extraordinarius*, and, in 1873, *ordinarius*.

To Graefe the honor belongs of introducing into ophthalmology Lister's ideas of sterilization. These ideas, of course, required a great deal of modification, before they became of much use in our special field, and most of these modifications we owe to Graefe. Suppuration after cataract operations at once became a thing of the past, or at least of very rare occurrence.

Graefe was also the first to observe a cysticercus in, and to remove one from, the interior of the eye. This was very soon after the invention of the ophthalmoscope by Helmholtz (1851) and, in a very few years thereafter, Graefe had constructed a highly successful "special localizing ophthalmoscope," the object of which was to aid in the removal of cysticerci.

Perhaps his most important writing was: "*Klinische Analyse der Motilitätsstörungen des Auges*" (Berlin, 1858), which still remains a very useful work. From 1874 to '80 he published, together with Saemisch, the world-renowned "Graefe-Saemisch *Handbuch der Gesamten Augenheilkunde*." To this monumental affair he contributed the article on "The Disturbances of Motility of the Eye."

He was a very prolific writer. Among his numerous contributions, not already mentioned, the following are most important: "Ueber Cysticercus-Extraction aus den tiefsten Theilen des Auges, mit Construction eines Localizations-Ophthalmoskops"; "Ueber Ischaemia Retinæ"; "Ueber das Binocularsehen bei Schielenden"; "Ueber Wundbehandlung bei Augenoperationen"; "Ueber Extraction Unreifer Staare"; "Ueber Enucleatio Bulbi"; "Ueber Caustische und Antiseptische Behandlung der Conjunctival-Entzündungen, mit Besonderer Berücksichtigung der Blennorrhoea Neonatorum."

As a man, Alfred Graefe was upright, honest, amiable. High and low, young and old, alike revered and honored him. He was no mere dry-bones of a scientist, but was ever a charming companion, a loyal and serviceable friend. He wrote a good deal of poetry, and had he

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* Graefe seems to have been a careful refractionist, as well as a brilliant operator. Thus, *The Ophthalmoscope*, July, 1908, p. 560: "Describing the life of that eminent Scot, Sir Donald N. Wallace, the 'World' makes a singular statement about the state of ophthalmic knowledge in this country some 40 years ago. While a student in Edinburgh in the early 60's Sir Donald found that he was unable to read for more than a few minutes at a time. He accordingly consulted 'the best men' in England, but it was not until he saw Graefe in Berlin that the cause of his distress in the shape of astigmatism was diagnosed and remedied."

not chosen to become an ophthalmologist, he might very well have been a poet of the first rank.

There was really a good deal of boyish fun in him. Thus one writer relates: "Having removed two cysticerci in one sitting from one and the same eye (July 12, 1892) he, in a jovial manner, announced to his friends and acquaintances, elegantly printed on a gold-bordered card: 'The happy delivery of two lively cysticerci.' "

He was always a frail, sickly man, and was accustomed to declare that, but for the constant attention, often the actual nursing, of his wife, he would never have accomplished anything worth mentioning.

Because of ill health, he retired in 1892 from active practice and the direction of the "Klinik," and returned to beautiful Weimar. Here, for a number of years, he continued to write. He died at Weimar, April 12, 1899.

In his honor was founded the well-known "Graefe Medal," a mark of distinction conferred "every tenth year on that person of whatever nationality who has done most to advance ophthalmology." Two copies of the medal have been conferred: the first on H. von Helmholtz, the second on Th. Leber.—(T. H. S.)

Graefe, Carl Ferdinand von. A famous general surgeon of the early 19th century, the father of Albrecht von Graefe and himself a well-known ophthalmologist. Born at Warsaw, March 8, 1787, the son of an agent of Count Moszynski, he pursued the study of medicine at Dresden, Halle, and Leipsic. At the last named institution he received his degree in 1807. In 1808 he became Court Councillor and Body-Physician to the reigning duke of Anhalt-Bernburg-Alexius in Ballenstedt. Here he erected a hospital, and was otherwise very active. In 1810 he was called to Berlin as professor-in-ordinary and director of the Clinico-Chirurgico-Ophthalmic Institute. His long, numerous and very important services to the army we cannot here enumerate. In 1826 he was ennobled by Czar Nicholas of Russia, and the honor was recognized by his own king. In 1830 he was called to London to treat Prince George of Cumberland for an ocular affection. Having gone to Hanover for the purpose of performing an ophthalmic operation on the Crown Prince, he died there July 4, 1840.

As an operator on the eye, C. F. von Graefe was absolutely unexcelled. He was also a brilliant lecturer on ophthalmology, and a writer of no mean merit. His investigations into the cause, nature, and cure of Egyptian ophthalmia, are of very great value today, and are often referred to by ophthalmic writers when treating of this disease.

In the general field his light burned still more brightly. He was

the first in all Germany to perform a staphylorrhaphy. He invented a combination of the Indian and the Italian methods of rhinoplasty—a procedure which still is known under the name of "The German Method." He was the first in Germany to tie the innominate artery. He invented the "compressorium" for the meningeal arteries, the ligature-staff, an operating-table, the coreoncion, and numerous other instruments and paraphernalia.

His most important writings are: 1. Angiektasie, ein Beitrag zur Rationellen Cur und Erkenntniss der Gefässausdehnungen" (Leipsic, 1808). 2. "Normen für die Ablösung Grösserer Gliedmassen nach Erfahrungsgrundsätzen Entworfen" (Berlin, 1812, with 7 plates). 3. "Rhinoplastik, oder die Kunst, den Verlust der Nase Organisch zu Ersetzen" (Berlin, 1818, with 6 plates). 4. Die Gaumennaht, ein Neuentdecktes Mittel" (*Jour. für Chir. u. Augenh.*, 1820). 5. "Die Epidemisch-Contagiöse Augen blennorrhoe Aegyptens in den Europäischen Befreiungsheeren" (Berlin, 1823).—(T. H. S.)

Graefe, Edward Adolf. Younger brother of Carl Ferdinand von Graefe. Born May 10. 1794, at Pulsnitz, in the Kingdom of Saxony, he studied medicine at Halle and Berlin, receiving his degree at the latter institution in 1817. In 1820 he settled in Spremberg, but five years later removed to Berlin. He was rather a voluminous contributor to the literature of general medicine, and composed a number of papers on ophthalmologic subjects. Of these the most important is "Erfahrungen über den Lichtstrahlen Brechende Vermögen der Durchsichtigen Gebilde in Menschlichen Auge" (1820). He died at Unruhstadt in the Province of Posen, June 16, 1859.—(T. H. S.)

Graefe's collyrium. The celebrated *collyrium adstringens luteum.* It is made as follows: camphor, 10 grains; alcohol, 1 ounce; chlorid of ammonium, 15 grains; sulphate of zinc, 30 grains; croci pulv. hispanici, 2 grains; distilled water, 5 ounces. One drop of this, after filtration, is used morning and evening.

Graefe's sickel needle. This is one of the best known (and one of the oldest) knife-needles for the discission of cataract.

Graefe's Sickle-Needle.

Graefe's sign of exophthalmic goitre. When the upper lid only imperfectly follows the downward movement of the eyeball.

Graefe's spots. Certain spots near the supraorbital foramen, or over the vertebræ, which, when pressed upon, cause a sudden relaxation of the orbicularis in cases of blepharo-facial spasm.

Graefe's test. This is one of the numerous prism tests for feigned blindness. See **Blindness, Simulated.**

Grafting. GRAFTS IN OPHTHALMIC SURGERY. The insertion of a small portion of skin, mucous membrane, etc., into or upon a raw surface or tissue deficient in the desired structure, or so placed for protecting or increasing the bulk or area of the parts. The various methods are described under **Blepharoplasty,** p. 1040, Vol. II, of this *Encyclopedia.*

In addition to the matter under that heading, the *lip-membrane graft for the relief of entropion* of Gifford, first described by him (*Am. Journal Ophthalm.*, Jan., 1892) and afterwards employed by W. O. Maher (*Ophthalmoscope,* April, 1914), is worthy of mention. Gifford recently (*Ophthalmoscope,* p. 698, Dec., 1914) draws attention to the fact that before 1892, Noisewski had advocated the grafting of lip membrane into the under side of the lid, but this was for the cure of inveterate trachoma, not for entropion. The trachomatous parts of the tarsus are scraped or cut away and membrane put in its place. Gifford has tried it in a few cases, and can testify to its effectiveness, when extirpation of the tarsus is not desirable.

The technique consists in making an incision through the tarsus from the inner surface, about 3 mm. from the free margin. This cut is made to gape by inserting three sutures as follows: the needle is passed through the outer edge of the free margin of the lid, taking a bite rather more than 1/16th inch wide, then it is passed through a small fold of the lid-skin about 3/16ths inch farther away from the lid-edge. Before the threads are tied, a bit of wet cotton is rolled into a hard cylinder about 3 cm. long and 5 mm. in diameter. This is slipped between the loose loops of thread and the outer surface of the lid so that when the threads are tied they press the cylinder against the lid and evert its margin. Into the tarsal cut thus made to gape, one can introduce either a Thiersch flap or a strip of lip-membrane, and if a little hemorrhage is started by scratching the sides of the cut here and there (to get fresh fibrinogen), and the graft is carefully pressed into the gap with a moist instrument, it heals, almost invariably, without any retaining sutures. See, also, **Cornea, Transplantation of the.**

Graham, James. A well known London physician, who seems to have devoted considerable attention to the eye. His only ophthalmologic writing is "Thoughts on the Present State of the Practice in Disorders of the Eye and Ear, etc." (London, 1775). The date of his birth is not known, but he died in 1830 at a very advanced age.—(T. H. S.)

Graiæ. Literally, "the old women." Also called *Phorcydes.* They first appear in Hesiod (*Theog.*) and are by him declared to be daughters of the sea-god, Phorcys, by his sister, Ceto, and sisters of the three Gorgons. They are beautiful, well-dressed, and white of hair from birth. In Æschylus (*Prom. Vinc.*) they are described as monsters, swan-shaped, and possessing in common but one eye and one tooth, which neither the sun nor the moon had ever shone upon, and which they borrowed from one another as occasion demanded. Some of the poets make them guardians of the Gorgons. Their names are: Pephredo, Enyo, and Dino.

The Graiæ have been thought to symbolize the clouds, the transferable eye and tooth representing the flash of the lightning and its rapid interchange from one cloud to another.

For the connection of the Phorcydes, or Graiæ, with the Perseus myth, see **Gorgon.**—(T. H. S.)

Graisse. (F.) Fat; oil; adipose tissue; ointment.

Graisseux. (F.) Fatty.

Gramia. (L.) Lippitudo.

Gramme. (L.) A line; of the old authors, the margin of the cornea.

Gram's fluid. GRAM STAIN. GRAM'S METHOD. A test for amyloid liver, and a mordant in staining for tubercle-bacilli, consisting of iodin 1 part, potassium iodid 2, water 300. The preparation is taken from the color-bath, washed and plunged into this solution until it takes a blackish tinge, then washed in alcohol until decolorization is complete. This process is called *Gram's method.* (Gould.)

The terms *Gram-positive* and *Gram-negative* are employed to indicate the showing or otherwise of the microbes submitted to the test.

Granatapfel. (G.) Pomegranate.

Granatum. See **Pomegranate.**

Grand canthus. (F.) Inner canthus; internal canthus.

Grand cercle de l'iris. (F.) Annulus iridis ciliaris.

Grand mal. (F.) A term for fully-developed epilepsy; major epilepsy.

Grando. (Obs.) A small tumor of the eyelid; a chalazion.

Grand sympathique. (F.) The sympathetic nerve.

Granny knot. A double knot in which one end of the cord in the second knot is passed over or under the other in the same relative position as in the first knot.

Granular conjunctivitis. GRANULAR LIDS. "GRANULATED" LIDS. An acute conjunctivitis characterized by hyperemia, serous infiltration, swelling of the papillary portion, increased secretion, and the development of round, grayish-red, prominent structures, especially in the region of the retrotarsal fold and neighboring part of the palpebral

conjunctiva. These undergo definite changes and, in time, frequently lead to secondary changes in the cornea and deeper parts of the lids. The disease is usually trachoma (q. v.).

Granular lids, Simple. See **Conjunctivitis, Follicular.**

Granuloma. Simple granuloma. Granuloma simplex. A term used by Virchow to include such neoplasms as do not advance beyond the stage of granulation tissue. According to Parsons (*Pathology of the Eye*, p. 119) simple granulation-tissue tumors occur frequently as the result of irritation, ulceration, or injury. They are particularly common in chalazia which have broken through the conjunctiva or have been incompletely dealt with, and in tenotomy wounds. They may be sessile or definitely polypoid.

Microscopically they are typical granulation tissue with its great variety of cells, amongst which all kinds of leucocytes, endothelial cells, giant-cells, and young connective-tissue cells are found. They are richly pervaded by very thin-walled new vessels, and hemorrhages are common. It may not be easy to distinguish them from inflamed capillary nevi. They are usually uncovered by epithelium, but layers of rapidly growing epithelium often partially cover the peripheral parts, and islets of epithelium are often enclosed, especially near the surface.

They often bleed, being a cause of "bloody tears," and they also drop off as the result of the movements of the lids.

Simple granulomata may reach a large size and project between the lids, which partially strangle the pedicle. The head is then edematous, and the microscopical characters are not unlike those of myxomatous tissue. Moreover, the epithelium covering the surface dips into every crevice of the granulation tissue, so that the appearance of epithelioma may be simulated.

Granulation tissue often accumulates around embedded foreign bodies. One such case is reported by Uhthoff; the patient was a stonemason, and had a small growth on the conjunctiva which was taken for a melanotic sarcoma. Examination showed it to consist of granulation tissue with giant-cells, developed around quartz particles which gave an iron reaction.

Granuloma giganto-cellulare (of de Vincentiis). This is a synonym of chalazion or Meibomian cyst.

Granuloma iridis. (L.) The name first given by von Graefe to a small, non-malignant tumor of the iris, composed of a highly vascular, small-celled, fibrillar (sarcoma-like) tissue. According to de Wecker, this disease may be subdivided into simple, spontaneous, telangeiectatic, and traumatic forms.

Probably the great majority are tubercular in character—as demonstrated by Haab. See **Iris, Tubercle of the**; as well as **Tuberculosis of the eye.**

Granuloma of the conjunctiva. This is a neoplastic growth resembling a polypus. Granulomata differ, however, from polypi in this respect: they are not covered by conjunctiva, but are naked granulation masses. They arise from surfaces made raw either by ulceration or by operation. They are often found after an operation for strabismus, enucleation, or chalazion. They cause bloody tears and many of the miraculous instances of bloody lachrymation can be thus explained. They are soft, irregular on the surface, but often become smooth from friction. They may expand so as to cover one-half the inner surface of the upper lid. They should be removed by the scissors. The base should be cauterized. If this be thoroughly done, they do not return.—(J. M. B.)

Granuloma of the cornea. A very rare and exceedingly vascular tumor described by a few of the older writers as growing from the limbus, and considered as, perhaps, similar to a leucosarcoma. (Foster.)

Granuloma of the eyelid. See **Eyelids, Granuloma of the.**

Granuloma of the retina. Under this title Thomas and Coats (*Trans. Ophth. Soc. United Kingdom*, xxxi, p. 149, 1912) report a mass found in the retina beside the optic disk and showing the structure of a granuloma and other evidences of inflammation. The lesion was noted immediately after an attack of influenza, when a bright scarlet, flat area, surrounded by swollen nerve fibres, was observed with the ophthalmoscope. The patient was a lad of 18. Later the retina became detached, and the eye blind and painful, requiring enucleation.

Grape-sugar. See **Glucose.**

Grapheus, Benevenutus, of Jerusalem (also called, Benvengut, Beneventus, Vengut, Grassus, Grassi, Grasso, and Ben Vengut de Salerno). The most famous ophthalmologist of the Latin (European, or Christian) Middle Ages, and the author of the first monograph on diseases of the eye printed by means of movable types. The time and place of his birth and death are all unknown; Hæsar believes he was born in Jerusalem. It is likely that he flourished in the 14th century, but Hirschberg refers him to the middle of the 12th. He was probably a Jew; he certainly studied at Salerno, and quite as certainly practised in Italy and the South of France. He wrote a book on diseases of the eye, called *"Practica Oculorum,"* which, for centuries, was the standard work of its kind throughout Christian Europe. Numerous manuscripts of this treatise are still extant, written in various early

Western European languages, as well as in Latin, and, as early as 1474, it received the honors of print.

Despite its great and long-standing popularity, however, the book possesses but little original value. It seems to have owed its remarkable acceptance to the fact that it comprised not only the oculistic science of the ancients, but also that of the Arabians. We should recall, in this connection, the author's Oriental origin, together with the fact that the other physicians of Western Europe at that time were, for the most part, acquainted with the writings of the ancients only.—(T. H. S.)

Graphology. The science of diagnosticating diseases, such as aphasia, locomotor ataxia, etc., by the person's handwriting.

Graphoscope. An instrument invented by Giraud-Teulon, a convex lens of 2 dioptres refractive power, 50 ctm. focal length, and 10 or 12 ctm. aperture, mounted in a plane parallel to the plane of the surface, which occupies the focal point. It was recommended for the treatment of asthenopia due to esorphoria and of progressive myopia.

This term is also used to designate an instrument for magnifying photographs, etc., with the aid of a single lens.

Gras. (F.) Fat; fatty; of plant-organs, succulent; thick; also, a fatty or plump structure or substance.

Grasmeyer, Paul Friedrich Herman. The first one in history to employ a mydriatic in connection with diseases of the eye. Born at Hamburg, Germany, he received his medical degree at Göttingen, where he settled for practice. While there he wrote "Diss. de Conceptione et Foecundatione Humana" (Göttingen, 1789), "Abhandlung von Eiter und den Mitteln, ihn von Allen ihm Aehnlichen Feuchtigkeiten zu Unterscheiden" (Göttingen, 1790).

Later he removed to his native Hamburg, and there he first made use of belladonna in the practice of ophthalmology. In the presence of Reimarus, in 1796, he extracted a cataract *via* a pupil which had been dilated for that purpose by means of belladonna.—(T. H. S.)

Grass. Graminaceæ. Grass as an ophthalmic remedy is recommended by both Pliny and Dioscorides. First, the grass was boiled; then to the decoction were added wine, honey, frankincense, pepper and myrrh. Finally, the whole was boiled again in a copper kettle. The resulting mixture was said to be especially good for epiphora.—(T. H. S.)

Grasso. See **Grapheus.**

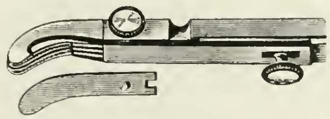
Gratama's test. This is a test for simulated blindness applied by means of an instrument made of two parallel tubes. Baudry (*System of Diseases of the Eye*, p. 885) describes these as being provided at both

ends with sliding plates, that cut off a part of the width of the tubes, and in which there are rectangular apertures. Beyond the intersection of the two visual lines a printed scale is placed in front of one of the tubes and a white card in front of the other. The transposition of the images being obtained by the intercrossing of the visual lines, the malingerer reads with the eye that is declared to be amblyopic what he thinks he is reading with the sound eye. To this apparatus have been added two three-degree prisms, placed base inward inside the tubes near their ocular ends in such a way that the superimposed letters form words. This test presupposes, it is unnecessary to say, that the person examined enjoys binocular vision.

Grating. In optics, a glass minutely ruled with fine parallel lines, the whole acting to produce dispersion of chromatic rays.

Gratiolet's bundle. Optic radiations running into the occipital cortex.

Grattage. This method of removing the granulations from the lids,



Weeks' Grattage Knife.

especially in trachoma is closely allied to **Brossage**. The operation may be performed with a pair of fixation forceps, a three-bladed scarifier, a tooth-brush, and a solution (1 to 500) of bichlorid of

Trachoma Rake for Grattage.

mercury. The everted lid being held by forceps, the surgeon thoroughly scarifies the conjunctiva and scrubs the incised surface with a stiff brush soaked in the bichlorid solution. Cold applications are to be used for a few days. A probe is used daily to prevent the formation of adhesions between the palpebral and ocular parts of the conjunctiva.—(J. M. B.)

Other methods include the use of pummice stone employed since the days of Galen (q. v.), sand paper (Coover), rough dry gauze (Webster Fox) and similar agents thoroughly rubbed on the exuberant granulations in such a way as to crush and remove them from their beds in the conjunctiva without serious damage to that mucous membrane. See **Trachoma.**

Grauer Staar. (G.) Senile or gray cataract.

Graue Salbe. Gray ointment. See **Mercurial ointment.**

Gravelle. (F.) An old term for chalazion.

Graves' disease. See **Basedow's disease**; as well as **Exophthalmic goitre.**

Graves, Robert James. A famous physician of Ireland, by some considered as the discoverer of the so-called Graves' disease, or exophthalmic goitre. Born at Dublin in 1797, he studied at Dublin, London, Berlin, Göttingen, Hamburg, and Copenhagen. In 1821 he began to practise in Dublin. A short time afterward, he founded the Park Street School, in which he taught medical jurisprudence, anatomy and internal medicine. He was a skilful diagnostician, and a teacher of unquestioned genius.

He was physician to the Meath Hospital, the County of Dublin Infirmary and the Hospital for Incurables. In 1827 he became Professor of the Institutes of Medicine at King's and Queen's College of Physicians. He was also a Fellow and Censor of the College of Physicians.

For ten years he was one of the editors of the *Dublin Journal of Medical and Chemical Science,* and he contributed numerous articles to this and to various other periodicals. Among his best known books are: 1. *Clinical Reports of the Medical Cases in the Meath Hospital and County of Dublin Infirmary during the Session of 1826-27* (in collaboration with Stokes; Dublin, 1827). 2. *A Selection of Cases from the Medical Records of the Meath Hospital* (in collaboration with Stokes; Dublin, 1827). 3. *Lecture on the Functions of the Lymphatic System* (Dublin, 1828). 4. *Clinical Lectures Delivered during the Sessions of 1834-5 and 1836-7* (Philadelphia, 1838). 5. *A System of Clinical Medicine* (Dublin, 1843; various editions in other years and countries). 6. *Clinical Lectures on the Practice of Medicine* (Dublin, 1844). His chief performance was the discovery of the symptom-complex which is sometimes called Graves' disease, sometimes Basedow's disease, and, perhaps most frequently of all, exophthalmic goitre. For a discussion of the question of priority in connection with this matter, see **Basedow.**

Graves died March 20, 1853, aged 56. Twenty-five years afterward, a statue was erected to his honor in Dublin.—(T. H. S.)

Gravidanza. (It.) Pregnancy.

Gravidität. (G.) Pregnancy.

Gravimeter. An instrument for the measurement of specific density.

Gravimetric. Pertaining to measurement by weight; opposed to volumetric.

Gray degeneration. A term commonly applied to the ophthalmoscopic appearances of certain forms of optic atrophy, especially in tabes dorsalis.

Gray, Henry. One of the greatest anatomists of all time, of considerable importance in ophthalmology both because of the ocular portion of his "*Anatomy, Descriptive and Surgical*" (familiar to students and physicians alike), and also because of his "*On the Anatomy and Physiology of the Nerves of the Human Eye*," which brought him, in 1839, the triennial prize of the Royal College of Surgeons. He was Professor of Anatomy at St. George's Hospital and Assistant Surgeon at the same institution. This remarkable man died at the early age of 36, in June, 1861.—(T. H. S.)

Gray oil. OLEUM CINEREUM. A semifluid, fatty, mercurial liquid introduced into medicine by Lang, of Vienna, in 1886. It is used in the treatment of syphilis by injections. It is prepared as follows: A given quantity of lanolin—1 or 2 drams—is rubbed up with sufficient chloroform to emulsify it. This mixture is to be thoroughly triturated, during which operation the chloroform will evaporate. While the mixture is still in a fluid state, metallic mercury to the amount of double the quantity of the lanolin is to be added, the trituration being meanwhile continued. As a result, a pomade of mercury is left, which represents two parts of mercury and one part of lanolin. This is called strong gray lanolin ointment. From this salve-basis a 50 per cent. oleum cinereum, or *gray oil*, may be obtained by mixing three parts with one part of olive oil. A mild gray lanolin ointment may be made in the same manner as the strong, by taking equal parts of lanolin and mercury and thoroughly mixing them. From this salve-basis a 30 per cent. gray oil may be made by mixing six parts with four parts of fresh almond-oil or olive-oil. (Gould.)

Gray ointment. See **Mercurial ointment.**

Gray powder. MERCURY WITH CHALK. HYDRARGYRUM CUM CRETA. CHALK MIXTURE. Contains mercury 38, clarified honey 10, prepared chalk 57, water q. s. Dose, gr. ss-x; generally prescribed in children's diseases.

Greater canthus. Inner canthus.

Green, Admiralty. See **Eyes of soldiers, sailors, etc., Examination of the.**

Green blindness. Achloropsia.

Green cancer. A common name for chloroma (q. v.).

Green cataract. (Obs.) Glaucomatous cataract.

Green soap. See **Soft soap.**

Green spot about the macula. This macular phenomenon is analogous to the brown or black spot seen in a certain percentage of myopic individuals.

Stargardt (*Zeitschr., f. Augenheilk.*, p. 327, April, 1912) and Harrison Butler have both described this rare affection, which Butler considered as a formation of a hole and changed coloring matter of the blood. Stargardt's patient was a woman, aged 28, with myopia of 17 D., annular broad staphyloma and diffuse atrophy of the fundus, which contained very little pigment, except at the macula. In the center of the macula was an irregular quadrangular patch, 1½ disc diameters across, of emerald-green color. It was sharply-defined, chiefly by a seam of fine, black pigment, corresponding in intensity and lustre to the tapetum of animals. It was neither depressed nor elevated, was traversed by two small retinal vessels, and the choroid under it was preserved, since choroidal vessels could be seen passing under it and emerging from it at the other side. There were no hemorrhages. A macular hole could be excluded, on account of the preserved retinal vessels, but from the central scotoma a destruction of the cones and rods could be inferred.

Stargardt considers the affection analogous to the central black spot in myopia described by Fuchs, and as found anatomically by Lehmus, produced by a proliferation of pigment epithelium, due to a progressive nutritive disturbance. The green color results from a proliferation of the pigment epithelium which at the same time loses the greatest portion of its pigment. The proliferated cell mass acts in the same fashion as the tapetum cellulosum of carnivorous animals which, as an opaque medium, converts the black color into blue-green, probably as an interference phenomenon. The blood, circulating in the choroid, gives an admixture of yellowish-red to the bluish tint and thus produces the green color. See **Black spot about the macula.**

Greene, Duff Warren. A well-known ophthalmologist of Dayton, Ohio. He was born at Fairfield, Greene County, Ohio, May 17, 1851, the son of Dr. John W. Greene, a general practitioner of that place. He attended the Ohio Wesleyan University, at Delaware, Ohio, for two or three years, but did not graduate. His medical degree was received at the Ohio Medical College, Cincinnati, in 1876.

For a time he practised general medicine at Fairfield in partnership with his father. Then, pursuing the study of ophthalmology for several months in New York City, he removed from Fairfield to Dayton, where he practised as an ophthalmologist until the very day, almost hour, of his death—more than thirty-one years.

In 1888 he studied ophthalmology in Vienna for six months. In

1909 he went to Julundur, India. where he made a special study of the intracapsular method of cataract extraction as practised by Colonel Smith. In 1912 he proceeded again to Europe, where he studied the eye in various hospitals in all the medical centers.

In 1884 he was appointed oculist and aurist to the National Military Home, Ohio—a position which he held twenty-nine years, until his death. He belonged to numerous medical societies, general and special, and in 1912 was made a member of the Oxford Ophthalmo-

Duff Warren Greene.

logical Congress. For the last ten years of his life he was associated in practice with Dr. Horace Bonner.

Dr. Greene was a voluminous and excellent contributor to ophthalmic literature. Aside from numerous journal articles, he wrote most valuable chapters on the intracapsular operation for cataract, in Vol. II of Casey A. Wood's *System of Ophthalmic Operations,* and in this *Encyclopedia.*

Dr. Greene was a man of great enthusiasm and almost limitless capacity for work. Nevertheless, he was not what is termed a slave to his profession. He went on long vacations, in summer, in the northern portion of the United States and in Canada, hunting and fishing.

Numerous trophies of his outdoor skill adorned his home. He was, for a time, a member of the Ohio State Fish and Game Commission.

He was a member of Mystic Lodge, A. F. and A. M.; Unity Chapter, R. A. M.; the Reed Commandery of the Knights Templars; and of the Antioch Temple of Shriners. He was long a member of Grace M. E. Church, and, shortly before his death, was elected a member of the official board.

In 1877 Dr. Greene married Miss Belle Norton, of Delaware, Ohio. Of the union were born two children, both of whom died in infancy. The Doctor died Aug. 16, 1913.

The manner of Dr. Greene's death was touching in the extreme. For a long time he had felt distress about the heart, but, in his strong-willed way, had bravely continued at work. The very forenoon of the day on which he died, he went to his office, and, attending there to certain minor matters, proceeded to St. Mary's Hospital, and there performed an important surgical operation. Later in the day, accompanied by his wife, he was proceeding in his automobile to one of the railway stations to meet a number of friends. But the hand of Destiny was on Dr. Greene. Just before they reached the station he besought his wife to halt the automobile, so great had become the pain in the region of his heart. She did as he requested, and the Doctor, pillowing his head on his wife's shoulder, passed silently away.—(T. H. S.)

Green, John. A well-known ophthalmologist of St. Louis, Mo., inventor of Green's operation for entropium, Green's extirpation of the lachrymal sac, Green's styles, Green's tendon-tucker, Green's test-types, etc. He was born at Worcester, Mass., April 2, 1835, the nephew, grandson, and great-grandson of doctors, all of whom bore the name of John Green and all of whom resided at Worcester, Mass. The subject of this sketch entered Harvard College in 1851, received the degree of A. B. in 1855, that of S. B. in 1856, A. M. in 1859, and M. D. in 1866. From 1858-'60 he studied medicine in Europe.

In 1857 he accompanied Prof. Jeffries Wyman on a scientific expedition to Surinam. Four years later he began to practise medicine in Boston. In 1862 he served on the Western U. S. Sanitary Commissions, and was for a time acting assistant surgeon in the armies of the Tennessee.

He was a delegate to the American Medical Association in 1864, 1865, 1873 and 1877.

In 1865 he went again to Europe for further study in ophthalmology, and on returning to America, removed to St. Louis. There he at once became a successful and influential ophthalmologist.

Dr. Green was made a member of the American Ophthalmological Society in 1866, and was one of the charter members of the American Otological Society. He was a member of the International Ophthalmological Congress in 1872, a delegate to the International Medical Congress in 1876 and secretary in that congress to the section on ophthalmology.

John Green.

He was appointed full professor of ophthalmology and otology in the St. Louis College of Physicians and Surgeons in 1866, lecturer on ophthalmology in the St. Louis Medical College in 1871, surgeon to the St. Louis Eye and Ear Infirmary in 1872, consulting ophthalmic surgeon to the St. Louis City Hospital in 1872, and ophthalmic surgeon to St. Luke's Hospital in 1874.

He married Harriet Louisa, daughter of George W. Jones, of Templeton, Mass. Miss Elizabeth Green and Dr. John Green, Jr., of St. Louis, are their children.

Dr. Green died at his home in St. Louis, Dec. 7, 1913, and, with his passing, there was removed the last of that great early western trio—Holmes, of Chicago; Williams, of Cincinnati; and Green, of St. Louis.

Dr. Green was low in stature, of full habit, short-bearded, rapid and curt in his speech, supersensitive, irascible, yet, withal, extremely kindhearted. He was somewhat feared by many of his students, but was also greatly respected and liked by all of them. Indeed, he received from them the crowning mark of affection—a nickname—"Johnny."

I cannot close this sketch without the quotation of two or three anecdotes about this most remarkable and highly individual man. The first of the stories is by Dr. Washington E. Fischel:

"We will admit that Dr. Green was severe, yes, a trying taskmaster with those who thought they were entitled to preferential consideration and forbearance. He was often wearied by unnecessary questions and irrelevant statements when in the midst of a tremendously busy day's work. It was then that he would burst out in exclamations that would strike hard and cut deep into the vanity or self-conscious pride of the offending, or—better said—the offensive questioner. On one occasion the wife of a prominent townsman was particularly insistent in plying absurd questions and volunteering her diagnosis of her eye condition. Dr. Green at first politely requesting her not to disturb or distract him by needless questioning and personal experiences, finally told her—still politely, the story goes—that he much preferred to have nothing more to do with her. The woman, nothing daunted by his refusal to continue his professional services, proved not averse to go on with her dissertation on her case. That proved too strong a temptation for an honest expression of his conviction. Looking up from his record of another case to which he had in the meantime directed his attention, he burst out with the exclamation: 'Madam, go home and tell your husband he has a fool for a wife.' Who but Dr. Green could have dispatched such a message to a husband by such a messenger? I relate this story as illustrative of the courage of our friend. Perhaps undiplomatic; but the applied epithet was correct, as on a subsequent occasion the husband, in a small gathering of friends, admitted the fitness of Dr. Green's allegation."

The second of the anecdotes is also by Dr. Fischel: "I recall with a feeling of great affection for Dr. Green an act of sympathetic consideration, of the big, warm-heartedness and helpfulness of the man. Some years ago Dr. Green appeared at my house at two o'clock in the morning. It was a bitter cold night. Apologizing for awakening me,

he asked whether I would see one of his poor patients with him, whom he feared was seriously ill. I accompanied him to a boarding house, where in a very small rear room, overheated and practically impossible of ventilation, I found an old woman in an attack of pneumonia. There was no one on hand to care for her. This is what happened. Dr. Green called the landlady, and finding out that a large front room was unoccupied, immediately engaged it, and the patient was forthwith carried into comfortable lodgings. He promised the attendance of a trained nurse later in the morning, and in the meantime assumed the responsibility of carrying out my instructions. There was no chance for me; the poor woman had in the first instance put herself in his care, and it was his privilege as well as his duty to tide her over that night. No reasoning to the contrary would prevail. It was truly a benediction to witness his tenderness and kindness; how he gladly deprived himself of a well-earned sleep to minister to this suffering fellow creature without a thought of self. It was ever so. He was always pedantically conscientious in his professional attention to those who came to him without means, without prestige—just to him—knowing that they would receive at least as skilled and kindly attention as the more fortunate of human kind.''

The third of the stories is by E. A. Engler, LL. D.: ''When Dr. Green was approaching the age of sixty years, that is to say, when I was some twenty years or so younger than I am now, he called on me one afternoon in my office, as he was in the habit of doing from time to time when he wished to get away from his grind, and his occupation permitted, and said to me quite familiarly, 'John' (and he called me 'John' because that was not my name), 'I have come to make a confession to you and to ask your help.' I replied, 'Well, Dr. Green, both phases of that statement interest me very much.'

'' 'You know,' said he, 'when I was a youngster I went to Harvard College for an education. Now you may not have discovered it, but it is a fact, that the teaching in Harvard College, and especially the teaching in mathematics, has improved since I was a college student.'

''To this I replied, 'I hope, Doctor, that what you say is true, because I myself am engaged, and have been all my life engaged, in attempting to improve the teaching of mathematics.'

''He continued, 'We had a prescribed course of study in those days, and, therefore, I had to study mathematics. I suppose I had about as much brains as the rest of the fellows; at all events, I did not consider that I was a fool; but they had a habit of turning loose on us the young fellows who had just graduated from the college the year before and they were to teach us mathematics. As you know, I have the kind

of mind that is not satisfied by a statement which I do not understand. A lesson would be assigned to us from a text-book and we would be expected to come to the next exercise with that lesson learned. I used to try for a while to learn the lessons, but had difficulties. Then I would come to the instructor for help; I was invariably told to go and read the book. I had tried to read the book and could not understand it, and it was clear to me that the teacher did not understand it because he was unable to help me. Finally I concluded there was no use in my attempting to learn mathematics. Not getting any good out of it, I became disgusted with the whole field of mathematics and so would do only the work required so as to pass. The way I did this was not to work at all during the ordinary term, but a week or two before the examination I hired a coach. He was a shrewd man, who knew what questions would be asked at the examination, and was skillful enough to fill me up with the correct answers; and in that way I scraped through. So I got through Harvard and received my bachelor's degree. I thanked my stars I did not have to bother with that matter any more; that was behind me.

" 'You know I profess to be an oculist, and have been doing something in that line for a number of years; and now I am confronted with a curious situation. I find, especially of late, that not only are nearly all the advances that are made in my science expressed in the publications in mathematical formulæ, which I cannot read, but even the text is so stated that it means very little to me, and I really don't know what I am to do. There is another phase of it. I have got a number of things in my head which I would like to express to other people and I find that I cannot do it because the expression of them requires a knowledge of technical mathematical language.'

"I listened with great interest to this story and I said, 'Well, Doctor, what do you want me to do?'

"He said, 'I want you to tell me how I can learn mathematics.'

"I replied, 'Doctor Green, I can tell you very simply how you can learn mathematics.'

"I told him that at the University of Berlin, while I was there, one of the most distinguished mathematicians in the world began a series of lectures by this statement (in German, of course; I will translate it), 'Mathematics is the science of things that are self-evident.'

"So I said, 'That being the correct definition, and I thoroughly agree with it, you can learn mathematics very easily; but I know no high road to that accomplishment. The only way is to begin at the bottom, if necessary go through the drudgery, and you will learn it in spite of yourself.'

" 'Well,' he said, 'that is what I want to do; but I want you to tell me how to do it.'

" 'Very well,' I replied; 'if you are in earnest I am ready to help you.'

"I went to a book case and got out a rather comprehensive treatise on Algebra written by an Englishman, far too heavy for the ordinary student.

"I said, 'Here is a book. Read it.'

"He said, 'I will put on this all the time I can spare. I have evenings and Sundays.'

"I said, 'Read this book. I think you will not read more than a page and a half before you find something that will bother you. Make a note of the difficulty. Proceed in this manner till you feel that you have got as far as you can go without help, and then come to me.'

"He started in. I would see him some weeks once, some twice, and each time he would have a lot of questions to ask me. I helped him over the difficulties. He went at it with an avidity and earnestness that I have never seen equalled by any student who has come under my instruction.

"After having gone through the subject of Algebra he did a similar thing with Trigonometry, Analytic Geometry, and the Calculus, and he got such a hold on these subjects that he could not only read intelligently the writings in his own line by others, but began writing himself and introduced mathematical formulæ and technical mathematical language to such a degree that it attracted the attention of oculists all over the world.

"By that work, which he continued directly with me for four or five years, and which he kept up on his own account till the time of his death, he got into the habit of looking at things from the mathematician's point of view, so that he used, in talking with me at least, mathematical phrases and terms which expressed his ideas so accurately that it would be scarcely possible to improve on his diction.

"This incident has always seemed to me a most remarkable thing, and it has impressed me particularly because of Dr. Green's age when he began this study, and his persistence in carrying it forward to a useful end. I shall make no further comment upon it."

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Green, Joseph Henry. A celebrated English surgeon, anatomist, physiologist and ophthalmologist. Born in 1791, at London, he studied at Berlin and also at St. Thomas's Hospital, London, where, in 1813, he was made prosector. In 1815 he became an M. R. C. S., and, three years later, instructor in anatomy and physiology at St. Thomas's. He was a very successful operator, especially for stone, having performed, before 1827, 40 lithotomies, with only one death. In 1828 he published his "*Manual of Modern Surgery,*" and two years later was appointed Professor of Surgery at the newly founded King's College, a position which, however, together with his private practice, he gave up in 1837. He was also for a few years a professor of anatomy at the Academy of Fine Arts. Green's "*Lectures on Diseases of the Eye*" reached its ninth edition in 1836, and was highly esteemed both by students and practitioners. In 1849 he was President of the

College of Surgeons, and again in 1858. He died Dec. 13, 1863, at his country seat, The Mount Hadley, near Barnet.—(T. H. S.)

Green vision. CHLOROPSIA. Up to the present time only a few cases of green vision have been observed and described. After the extraction of a lens for the relief of myopia, a thirty-two year old artisan who was suffering from tabetic optic nerve atrophy saw everything an emerald-green; after severe exhaustion there would appear to him red points on a green field. Green vision developed in a physician after having slept for a few hours in the full sunshine. Alter describes a case of green vision (which he calls monochromatopia for green) in a color-blind paralytic. In a tabetic, the field of vision appeared in green and violet spots, and the same condition was present with the eyes closed. One case of green vision was observed as an aura in an abortive epileptic attack, in a twelve year old girl.—(C. P. S.)

See p. 2202, Vol. III, of this *Encyclopedia*.

Green, Visual. A greenish pigment found in the rods of the retinæ of frogs and some reptiles. It resembles visual purple in the higher animals, and is similar in its properties.

Greffe epidermique. (F.) Epidermal graft.

Greffotome. A knife used in cutting surgical grafts.

Greisenstaar. (G.) Senile cataract.

Gregorian telescope. The first reflecting telescope made.

Greisenbogen. (G.) Arcus senilis.

Grêle. (F.) Chalazion.

Grenzwinkel (G.) Critical angle.

Griffin, Ovidus Arthur. A well-known ophthalmologist of Ann Arbor, Mich. He was born Dec. 10, 1872, at Fayette, Ohio, received the degree of B. S. at the State Normal School, Fayette, and his medical degree at the University of Michigan, June, 1899. He studied the eye, ear, nose and throat at New York, Philadelphia, Vienna and Berlin.

For three years he was Dr. Flemming Carrow's first assistant and demonstrator of ophthalmic and aural surgery and clinical ophthalmology and otology in the department of medicine and surgery in the University of Michigan. Until his death he continued to practise in Ann Arbor.

He was a member of the Ann Arbor Medical Club, the Washtenaw Medical Association, the American Medical Association, and the American Academy of Ophthalmology and Oto-Laryngology.

Among his more important writings are: 1. Disorders from Eye-Strain. (Read before the Michigan State Medical Society, at Petoskey, June, 1905.) 2. Complete Removal of the Faucial Tonsils. (Read before the American Academy of Ophthalmology and Oto-Laryngology, 1906.) 3. Ocular Symptoms of Nasal Origin. (Read before the Michigan State Medical Society, 1907.) 4. *Diseases of the Eye and Ear.* (A Student's Manual: Lea Bros., 1905.)

He invented a number of useful instruments, among them the well known Griffin tonsil scissors. He also designed a model operating chair.

Dr. Griffin was a stout, smooth-faced man; good natured, but very serious; and with a way about him that always inspired confidence.

Ovidus Arthur Griffin.

He was a man of the cleanest possible kind of life. He was a member of the First Methodist Church, and an active worker in that institution. He was a great lover of his profession and his home. He was a good story-teller, and an excellent listener. An ecstatic lover of the beautiful, his favorite pastime was the collection of reproductions in period furniture, of which he had many beautiful and valuable pieces in his house.

He married, June 20, 1901, Miss Jessie Almira Curtis. There were no children.

He died at Ann Arbor, Mich., Oct. 27, 1911, of spinal meningitis, contracted from a patient with a "walking" form of the disease. He was ill but a few days.—(T. H. S.)

Gril de la couche optique. (F.) Substantia reticularis; optic fibre crossing.

Grill-like keratitis. See **Cornea, Lattice-shaped opacity of the.**

Grimaldi, Francesco Maria. A famous Italian physicist, who discovered the diffraction and the interference of light. Born in Bologna, Italy, in 1618, he became an instructor in mathematics at the Bolognese Jesuit College, and died in 1663. His only work on optics was entitled, "*Physico-Mathesis de Lumine, Coloribus et Iride Aliisque Annexis* Libri II," which did not appear until 1665, that is to say, two years after his death. In this small volume we find, *inter alia,* an account of its author's great discoveries. First, he took up the diffraction of light. The experiment showing this phenomenon was performed as follows: In a room that was otherwise dark, a single cone of light was permitted to enter, and was caught upon a white ground, or screen. Then a staff was held between the screen and the place of entrance of the light, and the shadow of the staff on the screen was examined closely. Grimaldi then observed: 1. That the full shadow was larger than, by the ordinary calculation, it should have been. 2. On either side of the shadow was a zone of color, which, in the direction of the shadow, was blue, and, in the opposite direction, red. 3. The light-intensity and the color-intensity of both these color zones diminished from the shadow outwards. 4. If the light that entered the room was very bright sunlight, then certain zones of color appeared in the shadow itself.

These "influences" of the shadow on the illuminated portion of the screen, and *vice versa,* were called by Grimaldi himself "the diffraction of light," so that the discoverer of the phenomenon is also the inventor of the term. Grimaldi also correctly explained these influences of illuminated part on shadow and *vice versa,* as due to a bending of some of the rays of light, either inward or outward, as it passed by the border, or edge, of the shadow-casting body.

Next, Grimaldi, in his little book, took up the interference of light. This phenomenon he discovered in the course of an experiment by which he endeavored to show that diffraction is something altogether different and apart from both reflection and refraction. Laying aside the staff he had employed in the original experiment, he placed in the path of the light an opaque plate in which there was a small opening. Once again catching the light upon a white ground, or screen, he found the illuminated circle larger than, according to the size of aperture, might have been pre-estimated.

He next proceeded to make in the shutter of the darkened room a second aperture for light, and then, on a single screen, caught the two light-discs from the two apertures at such a distance that the light-discs partly overlapped each other. Then Grimaldi observed,

around each disc of light, a zone or ring of darkness, which, after the manner of the discs themselves, intersected each other. He also observed that the area which lay within both the rings was very much brighter than that which lay inside either one of the rings alone. Furthermore, the border of each disc was dark in the illuminated area of the other circle. Grimaldi's conclusion was: "An illuminated body can become darker, when to the light which it receives is added other light."

As will readily be perceived, Grimaldi did not eliminate from his experiment the influence of diffraction. He took, however, the very first step toward a knowledge of the interference of light, while further steps remained to be taken by Young, and especially by Fresnel. (See **Young, Thomas,** and **Fresnel, Jean Augustin,** in this *Encyclopedia.*)—(T. H. S.)

Grimaud, Aimé. A celebrated Paris physician, who paid considerable attention to diseases of the eye. Born at Angers, France, in 1789, he received his medical degree in 1818, became physician to the Bureau of Charity, and lectured for many years on internal medicine. He died Jan. 10, 1866.

Grimaud's only ophthalmologic writing was "*Traité de la Cataracte: Moyens Nouveau de la Guérir sans Opération Chirurgicale*" (Paris, 1842).—(T. H. S.)

Grimm, Johann Friedrich Karl. A well-known German botanist and physician, who devoted considerable attention to diseases of the eye. Born at Eisenach in 1737, he received his medical degree at Göttingen in 1758, and settled as general practitioner in Eisenach. He made an excellent translation of the Hippocratic Collection (First ed., Glogau, 1781-92; 2d ed., Glogau, 1837-39). His only ophthalmologic writing was his graduation dissertation, entitled "De Visu" (1758).—(T. H. S.)

Grippe, La. Also called *the grip.* See **Influenza.**

Groenouw's disease of the cornea. See **Cornea, Nodular opacity of the.**

Groove, Corneal. The depression that runs around the globe at the sclero-corneal junction.

Groove, Lachrymal. A gutter in front of the opening of the antrum, on the inner surface of the superior maxillary bone.

Groove, Optic. The groove on the superior surface of the sphenoid bone terminating on either side in the optic foramen.

Grooves, Lachrymal. Rarely, the canaliculi are (congenitally) replaced by grooves or gutters such as is found normally in some birds. See, for example, Depène (*Klin. Monatsbl. f. Augenheilk.*, p. 396, Sept., 1911) and **Comparative ophthalmology.**

Groping-test. In ophthalmology, a test for false orientation in paralysis of the ocular muscles. The affected eye does not locate objects in their true place, and if asked to point quickly at an object the patient's finger will be carried to one side of it.—(Gould.)

Gros mal. (F.) The well-marked form of epilepsy; major epilepsy.

Gros nez. See **Eyelids, Goundon of the.**

Gross anatomy. MACROSCOPIC ANATOMY. Anatomy considered without reference to histology or the details of minute structure. See **Anatomy of the eye.**

Gross appearances. Macroscopic appearances, without attention to minute details.

Grossäugig. (G.) Large-eyed.

Grösse. (G.) Magnitude.

Grosser Augenbrauenmuskel. (G.) The epicranius or occipitofrontalis muscle.

Grossissement. (F.) Magnification.

Gross, Samuel David. A famous general surgeon of Philadelphia, who was also widely known as an operator on the eye. He was born near Easton, Penna., July 8, 1805, the son of Philip and Juliana Brown Gross. After a classical education, he studied with Dr. Joseph K. Swift, of Easton, and also with Prof. George McClellan, of Philadelphia. Entering Jefferson Medical College in 1826, he there received his medical degree two years later, his graduation thesis being entitled "The Nature and Treatment of Cataract." He settled at once in Philadelphia, but soon removed to Easton, then to Cincinnati, Ohio, where, in 1833, he became Demonstrator of Anatomy in the Ohio Medical College. Two years later he was made Professor of Pathological Anatomy in the Medical Department of the Cincinnati College. Four years later he removed to Louisville, where he was professor of surgery in the University of Louisville for ten years. In 1850 he removed to New York City, where he succeeded Dr. Mott in the chair of Pathological Anatomy. The following year he returned to his former position at Louisville. In 1856, however, he returned to Philadelphia, in order to accept the chair of surgery in the Jefferson Medical College—a position which he held till about two years before his death.

Dr. Gross was a very prolific, as well as a clear and cogent, writer. His most important work, no doubt, was the well known *System of Surgery*, which passed through many editions. He wrote, however, a number of other important volumes. He was also one of the founders and chief editors of the *North American Medico-Chirurgical Review*.

After the reception of numerous honors, among them D. C. L.,

Oxford, and LL. D., Cambridge, Dr. Gross died in May, 1884.—(T. H. S.)

Ground glass. Glass, one or both surfaces of which have been ground with emery or some similar agent.

Groundsel. *Senecio vulgaris.* In the days of Pliny and Dioscorides, cross-wort, or groundsel, was employed, mixed with saffron and cold water, as a poultice for epiphora.—(T. H. S.)

Ground-substance (of the cornea). Substantia propria; the corneal substance proper.

Growing-cell. Growing-slide. A plain glass box adapted for the preservation of living micro-organisms.

Growth. A term generally synonymous with tumor.

Grube. (G.) Fossa; fovea; groove.

Grumeau. (F.) Clot.

Grumous cataract. Cataracta cruenta. An obsolete name for an opacity due to hemorrhage into the cornea, anterior chamber or vitreous.

Grünblindheit. (G.) Green blindness.

Grundfarben. (G.) Primary colors.

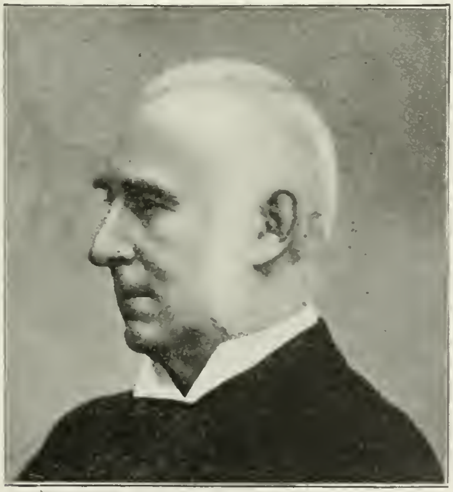
Grundlinie. (G.) Base line.

Grüner Staar. (G.) Green cataract.

Grünsehen. (G.) Green vision.

Grünspan. (G.) Verdigris.

Grut, Edmund Hansen. A famous European ophthalmologist. Born



Edmund Gottfried Hansen Grut.

at Copenhagen, Denmark, Jan. 15, 1831, he studied medicine in that city, and, later, ophthalmology in Paris and Berlin. He received his

degree in 1857, presenting as dissertation a treatise on the ophthalmoscope. From 1859-61 he was first assistant at the Surgical University-Clinic of the Frederick Hospital, Copenhagen, and in 1863 began to give instruction in diseases of the eye as privatdocent. From 1882-1890 he was full professor of ophthalmology at the Copenhagen University. He was a man of very great influence over the younger generation of Danish ophthalmologists. In 1889 he delivered the Bowman lecture before the Ophthalmological Society of the United Kingdom, of which he was an honorary member. He contributed numerous articles, chiefly on ophthalmologic subjects, to the Danish journal, "*Hospitals Tidende,*" and died in August, or September, 1907.—(T. H. S.)

Guachamacine. An alkaloid, probably identical with *curarin,* obtained by J. Schiffer from guachamacá. It is soluble in water, less soluble in absolute alcohol and insoluble in ether and in chloroform.

Guaco. (Sp.) In Central and South America and the West Indies, a name for various species of *Aristolochia* and *Mikania* having supposed alexipharmac properties. Guaco is employed as a preventive of, and remedy for, the bites of poisonous serpents, as a febrifuge and anthelminthic, in chronic rheumatism, and externally in purulent and blennorrhagic ophthalmia, chronic ulcers, etc.

Guaiacolbenzyl ester. See **Brenzcain.**

Guaicol. GUAIACOL. MONOMETHYLCATECHOL. METHYL ESTER OF PROTOCATECHIN. This agent is made from beechwood creosote by fractional distillation; is a faintly-yellow, limpid, oily liquid with an aromatic odor. It is insoluble in water.

Another preparation is in crystalline form, soluble in oils and slightly soluble in water; it is used in the same dose and for the same purpose as the preceding.

Tersan (*Pract. Med. Series,* p. 238, 1907) claims that the antiseptic, alterative, anesthetic, analgesic action of guaiacol is of service in diseases of the eye. As an application to the skin a 10 per cent. solution in oil or glycerin, either alone or in combination, in oily solution, with camphor or menthol, will be found useful in herpes zoster, furunculosis, phlegmonous dacryocystitis, etc. As a conjunctival application he employs a mixture of copper sulphate and guaiacol, each one part to 20 parts of glycerin. In burns he uses a solution of atropin (the alkaloid) in sterile, chemically pure oil to which may be added guaiacol, menthol and camphor 1/20. Internally and intramuscularly it is of use in scrofulous tuberculous and syphilitic eye affections.

H. L. Gowens (*Jour. Ophth., Otol. and Laryng.,* March, 1915) agrees with Darier that the drug in the form of a 2 per cent. ointment

and in 1 per cent. to 2 per cent. watery solution is of especial value in the various forms of ocular tuberculosis. *Guaiacol cacodylate* in 2 per cent. solution in sterile water is recommended as a subconjunctival injection in tuberculous affections of the anterior segment of the globe. By mixing the injection with a few drops of alypin it does not produce any inconvenience.

Guanidin. CARBOMIDINE. This agent is said by Lewin and Guillery to act as a mydriatic either when applied locally or when given in full doses to the lower animals.

Guarana. A dried paste prepared from the seeds of *Paullinia cupana vel sorbilis*, found in Brazil. It contains an alkaloid, guaranin, $C_8H_{10}N_4O_2 . H_2O$, identical with caffein. It is employed chiefly in migraine and other headaches. The commercial preparations are not always trustworthy. Dose of the fld. ext., mv-xxx; of *guaranin* gr. j-iij; of the solid ext. gr. iij-x; of the tincture (1 in 4) ʒss-j.

Guards, Eye-glass. See **Eyeglasses and spectacles, History of**; also **Eyeglasses and spectacles, Mechanical adjustment of.**

Gudden's commissure. A mass of fibers forming the upper (dorsal) part of the optic tracts. They are demonstrated in man with difficulty unless there is degeneration of the optic fibers proper.

Guenz, Justus Gottfried. A German anatomist, physician and surgeon, who devoted considerable attention to ophthalmology. Born at Königstein, Germany, March 1, 1714, he received his early education from his father, a highly educated minister, and his medical training at Leipsic, where he graduated in 1738. After a number of Wanderjahre, he settled at Leipsic, and became in 1747 professor of physiology, and, a little later, of anatomy and surgery. He was a celebrated lithotomist, and wrote a number of articles on cataract and glaucoma. In 1751 he was appointed body-physician to the Elector of Saxony. Shortly afterward (in 1751) he died.—(T. H. S.)

Guépin, Ange. A distinguished ophthalmologist of Nantes. He was born at Pontivy, France, Aug. 30, 1805, and received his medical degree in 1828. Having settled at Nantes, he there became professor of economic and industrial chemistry. In 1835 he became an ophthalmologist exclusively—so far at least as medicine is concerned, for he held a number of political offices. He was one of the founders of the *Revue Philosophique et Religieuse.* He died May 21, 1873.

His medical works are as follows: 1. Lettres à Ribes, de Montpellier, sur Divers Sujets de Méd., de Chir., et d'Hygiéne. (Nantes and Paris, 1836.) 2. Etudes d'Oculistique. (Paris, 1844.) 3. Nouvelles Etudes Théoriques et Cliniques sur les Maladies des Yeux: l'Oeil et

la Vision. (Paris, 1857.) 4. Des Eaux Mineralisées. (Paris, 1857.) —(T. H. S.)

Guépratte, Alphonse Pierre Prosper. A French naval physician, who seems to have devoted some attention to the eye. Born at Brest, July 20, 1808, he received his medical degree in 1842 at Montpellier. After about five years of practice in this city, he died Sept. 17, 1847, aged only 39 years.

His only ophthalmologic writing was "Hémeralopie des Pays Chauds, Observations Recueillies à. Bord de la Frégate Armide," etc. (*Gaz. Méd. de Montpellier,* 1847).—(T. H. S.)

Guérin, Jules René. A celebrated French physician, pathologist, and surgeon, who paid considerable attention to ophthalmology. Born at Boussu, Belgium, March 11, 1801, he obtained his medical degree at Paris in 1826. Two years later he was editor and proprietor of the *Gazette de Santé.* In 1838 he founded the Orthopedic Institute at Passy, where he himself performed a large number of orthopedic operations. In 1839 he was appointed Orthopedic Surgeon at the Children's Hospital. He died Jan. 25, 1886, aged 85. His only ophthalmologic writing was *Mém. sur l'Etiologie Générale du Strabisme* (2d ed., 1843).—(T. H. S.)

Guérin, Pierre. A French surgeon and ophthalmologist. Born at Lyons, France, May 26, 1740, he became a Fellow of the Royal College of Surgeons at Lyons, surgeon-in-chief of the Lyon Hôtel Dieu, etc. He died at Bordeaux, Feb. 13, 1827.

Guérin's only ophthalmologic writing was *Traité des Maladies des Yeux* (Paris, 1770).—(T. H. S.)

Guiding sensation. See **Fusion field.**

Guido. See **Guy de Chauliac.**

Guido de Cauliaco. See **Guy de Chauliac.**

Guillemeau, Jacques (1560-1613). A graduate of Paris, and one of the brightest pupils of Riolan, Courtin and Paris, he became physician-in-ordinary to the King of France and a surgeon of world-renowned ability. He was not very great as an ophthalmologist, but his book, *Des Maladies de l'Oeil qui sont en Nombre de Cent Treize aux quelles il est Subject* (Paris, 1585), on account of the excellence of its matter and the clearness of its literary style, was very popular in Germany and England, as well as in France, for many years. In England, indeed, it was well enough thought of to form the sum and substance of Banister's *One Hundred and Thirteen Diseases of the Eyes and Eyelids*—which, by the way, seems to have been the earliest general work on eye diseases in the English language.

Guillemeau's work is based almost entirely on the Arabians and the

Greeks, but it contains a few, if unimportant, original operations—among them one for lid-coloboma.—(T. H. S.)

Guillié, Sebastian. A well-known ophthalmologist of Paris. He was born at Bordeaux, Aug. 24, 1780, and received his professional degree at Paris in 1807. For a short time he was a field physician in the army. Then he became superintendent of the Institution for the Blind. Almost immediately afterwards he was arrested and imprisoned by mistake, and so remained in durance for a year. He seems to have been a man of quackish tendencies, for he advertised and sold at a high price a "Drogue Antiglaireuse," whereby he achieved a fortune.

His writings are as follows: 1. Traité de l'Origine des Glaires (devoted to the exploitation of his nostrum, and vigorously pushed to its 31st edition). 2. Rapport Fait à S. E. le Ministre . . . sur l'Etat de l'Institution Royale des Jeunes Aveugles, pendant les Exercices de 1816 et 1817 (Paris, 1818). 3. Nouvelles Recherches sur la Cataracte et la Goutte-Sereine (Paris, 1818). 4. Essai sur l'Instruction des Aveugles, etc. (Paris, 1817; 3d ed., 1820). 5. Rapport Fait à MM. les Membres et les Souscripteurs de la Clinique Oculaire de Paris pendant 1820, 21 (Paris, 1821). 6. Bibliothèque Ophthalmologique, ou Recueil d'Observations sur les Maladies des Yeux Faites à la Clinique de l'Institution Royale des Jeunes Aveugles; avec des Notes de Dupuytren (Paris, 1820, 21). Guillié died in November, 1865.—(T. H. S.)

Guipsin. An internal remedy usually given for the purpose of reducing vascular tension, and indirectly intended to relieve the intraocular pressure in glaucoma. See, for example, M. A. Terson (*Bull. de la Soc. d'Ophtal. de Paris,* Jan., 1912).

Gujasanol. DIETHYLGLYCOCOLLGUAIACOL HYDROCHLORIDE. This salt occurs as colorless crystals with a faint odor of guaiacol. It is very soluble in water; slightly in alcohol.

It is a mild antiseptic and used as such in simple acute and chronic conjunctivitis, in from 5 to 20 per cent. solutions three or four times daily. See **Guaicol.**

Gullstrand's ophthalmoscope. See page 4758, Vol. VI, of this *Encyclopedia;* also **Ophthalmoscope.**

Gum. Various sorts of gum, called generically *sarcocolla,* were employed by the ancient Greco-Roman physicians as a menstruum for various ophthalmic medicaments.—(T. H. S.)

Gum arabic. See **Acacia.**

Gumma. GUMMA OF THE OCULAR APPARATUS. This neoplasm is essentially a soft, elastic tumor resulting from secondary changes, often

caseation, of tertiary syphilitic inflammatory deposits. These growths may occur in any portion of the ocular apparatus, extra- or intracranial. Although this subject will also be considered under various captions, for example, **Syphilis**; **Eyelids, Gumma of the**, and under the general heading **Tumors of the eye**, yet it is considered proper to make here a few observations of the lesion as it most commonly affects the eyeball and its appendages.

Gumma of the lids is not rare; see **Eyelids, Gumma of the.**

Gummatous tarsitis is not uncommon; indeed Parsons (*Pathology of the Eye*, I, p. 6) speaks of the tarsus as particularly liable to syphilitic inflammation. It is then much enlarged, so that the lid cannot be everted, and is of cartilaginous hardness. When cut into it does not bleed. Both lids of the same eye may be affected. It is a tertiary affection, which runs a prolonged course of several months. Cases examined histologically have shown hyaline degeneration of the fibrous tissue with few nucleated cells. Near the surface the tissue was infiltrated with round-cells and partially replaced by granulation tissue, with new-formed connective tissue. In one case there were calcareous deposits. The vessels, especially the small arteries, showed hyaline degeneration, atrophy of the media, slight thickening of the adventitia, and enormous proliferation of the intima, amounting often to endarteritis obliterans. The veins suffered least. In one case, of seven years' duration, the conjunctival epithelium resembled epidermis; in another, of eight years' duration, the conjunctiva bulbi was xerotic.

For an account of *gumma of the conjunctiva*, see p. 3025, Vol. IV, of this *Encyclopedia*.

Gumma of the sclera. In this region primary gumma is an excessively rare neoplastic growth, although Andrews (*System of Diseases of the Eye*, III, 253) has reported a case.

Gumma of the cornea is also a most unusual tumor, although a few cases have been recorded.

Gumma of the iris. Gummatous iritis is, perhaps, the commonest form of ocular gumma. It appears in the later secondary stage of syphilis, and presents clinical signs peculiar to itself. In rare instances it is found in infants with hereditary syphilis. The iris shows one or more yellowish-brown or reddish-brown nodules, varying in size from a pin's head to a pea. They are found in the ciliary or pupillary border or midway between the two, and are often crossed by vessels. Although found in the secondary stage of syphilis, the name gummata has been applied to them. Unlike true gummata they do not break down or suppurate. They soon disappear under treatment without

leaving scars in the iris-tissue. Some authors apply the term *iritis papulosa* to this condition, and reserve the name gummatous iritis to those rare cases of true gummata which appear later in the history of syphilis.

Rollet (*Archives d'Ophtalmologie,* May, 1908) met with twelve cases of syphilitic iritis and classifies them in the following manner: (1) Circumscribed nodule; (2) gummatous pseudo-hypopyon; (3) diffuse syphilitic infiltration. (1) Of the circumscribed nodule he has seen eight instances; the nodule was usually solitary and about the size of a pin's head. The ages of the patients varied from 14½ to 50 years, and the interval since the appearance of the primary lesion from 5 to 14 months.

Gumma of the ciliary body is a rare condition, appearing in from one to three and one-half years after the initial lesion of syphilis. The gummatous tumor is preceded by an attack of iritis. The vision is rapidly reduced, the eye showing great conjunctival and ciliary injection. The cornea becomes hazy, the anterior chamber deep, and hypopyon is present. A yellowish-red tumor is seen projecting from the angle of the anterior chamber, and at a spot corresponding to its site there is a bulging of the ciliary region. This is of a purple color. Tension becomes increased; there is great pain and considerable constitutional disturbance, as shown by the presence of anorexia, furred tongue, insomnia, and elevation of temperature. Other nodules appear, and these develop into ciliary staphylomata, presenting a bluish-black color, owing to the pigment showing through the thin sclera. Under proper treatment, which has been instituted and continued for several weeks, the eye becomes clear, the hypopyon disappears, and the tension gradually diminishes. Vision improves, but generally is not restored. The staphyloma may diminish in size, but some bulging always remains. If the treatment is not efficacious, the eye becomes perforated, or atrophy of the globe may occur without perforation.

The diagnosis must rest upon the history and clinical signs as given above.

Prognosis should always be guarded in these cases. If the patient retains the globe intact and possesses vision equal to the counting of fingers at a few feet, he should be congratulated. Stieren, however, has recorded a case of gumma of the ciliary body, with vision reduced to perception of light, which recovered vision (6/8) under enormous doses (100 to 200 grains, three times a day) of potassium iodid.

Anti-syphilitic remedies should in treatment be pushed vigorously. Locally atropin or scopolamin drops must be used, and the usual remedies are to be prescribed for the relief of pain.—(J. M. B.)

An account of a gumma of the *ciliary body and optic nerve* is given by Matsukawa (*Klin. Monats. f. Augenheilk.*, Vol. 51, p. 665). A man, aged 32, had a hard chancre and inguinal buboes in April, 1911. Eight months later he had iritis and, after three months, exhibited papulous syphilitic iritis, which rapidly subsided after an intravenous injection of 0.6 salvarsan, followed by mercury and iodine for a month. On admission the Wassermann reaction was positive. Six months later he returned with a gumma of the ciliary body in the form of a bluish-red tumor at the inferior temporal limbus; an irregular pupil closed by grayish-white exudations, iris adherent to the lens; $V = 0$. On account of very severe pain the eye was enucleated.

The histologic examination revealed a gumma of the ciliary body and optic nerve. No spirochætes were found. Matsukawa considers this as a neuro-relapse and a luetic manifestation after salvarsan, although this condition generally occurs from four to five months after the primary sore, not one and one-half years, as in this case, and is not due to an intoxication by salvarsan.

Gumma of the choroid. Parsons (*Pathology of the Eye,* II, p. 462) says that true gummata of the choroid, characterized by necrosis, are of extreme rarity; indeed, only gummatous infiltration has hitherto been observed. The changes occur in the tertiary stage as well as earlier, but necrosis is absent. v. Hippel's case was essentially one of gumma of the ciliary body, with diffuse extension into the choroid and other parts of the eye. There is dense infiltration with small round cells, with some endothelial proliferation. The granulomatous nature is emphasized by the rich development of new vessels, mostly mere endothelial tubules. The distinctive feature is the fatty degeneration of the tissues, going on to total necrosis. Schöbl has also described thickening of the choroid with nodular infiltration, the largest nodules being in a state of necrosis. Endarteritis was noted, and this may account for the extensive degeneration.

Gummatous new formations of the optic disc are extremely rare. Mylius (*Klin. Monatsbl. f. Augenheilk.*, May, 1913) could find in literature only three cases. He reports the following: A woman, aged 25, came on November 1, 1911, complaining of impairment of vision of left eye for a week, which was reduced to counting fingers at 1/2 m. The ophthalmoscope revealed floating opacities of the vitreous. The optic disc was not visible, being completely covered by a dense, bluish-white mass, pervaded by a few, partly ectatic, blood vessels. The mass measured vertically, about two disc diameters; horizontally, three. The surrounding parts of the retina were slightly opaque. The tumor protruded 6 D. The outer borders of the visual field were

normal for larger objects; there was no absolute central scotoma. Wassermann was positive. Under mercurial inunctions the affection healed within six weeks; V. 5/5, fundus perfectly normal. The benign course indicated an affection of the surface of the disc without involving the optic nerve, apparently a perivasculitis with excessive formation of granulation tissue around the vessels of the hilus.

Gumma of the orbital periosteum is rarer than the same disease in the periosteal covering of the other cranial bones. The condition is a rarefying osteitis: i. e., the subperiosteal bone-cells undergo softening and become in structure similar to the gummatous tissue. The symptoms are those of ordinary periostitis with certain exaggerations. Nocturnal pain and neuralgia are prominent symptoms. The swelling is more circumscribed than in periostitis and simulates more a true tumor, exophthalmos being frequently produced if the gumma is in the deeper parts of the orbit. Orbital gummata cause great immobility of the eyeball, marked fixity of the eyeball being characteristic of this form of inflammation. They are amenable to specific treatment, but when they disappear great holes and depressions are left in the bones.—(J. M. B.)

Gummatous conjunctivitis. (Obs.) A localized conjunctivitis of plastic type, occasioned by the development of a gummy tumor in the conjunctiva or subconjunctival tissue. These gummy deposits usually occur in the course of the external rectus muscle or between the latter and the superior rectus. See **Gumma.**

Gummatous iridochoroiditis. A very rare disease, running a course similar to *iritis gummatosa*, but often involving the ciliary body, choroid, and sclera, and leading to perforation of the latter before resolution. See **Iritis, Syphilitic**; as well as **Gumma.**

Gum of the eye. A vulgar name for mucus secreted by the Meibomian glands and mixed with particles of dust, drying on the eyelids.

Gum-resin myrrh. See **Myrrh.**

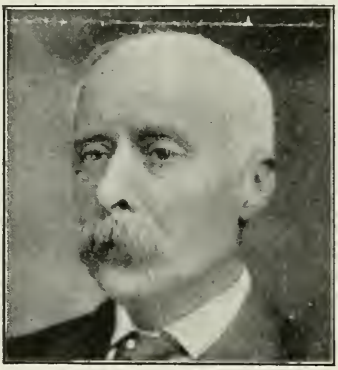
Gum tragacanth. See **Tragacanth.**

Gunn's dots. These are fully described on p. 3560, Vol. V. of this *Encyclopedia.*

Gunn, Robert Marcus. A celebrated English ophthalmologist, discoverer of "Gunn's dots," or, as he himself preferred to call them, "Crick dots." Born at Dunnet, Sutherlandshire, of Scandinavian stock, in 1850, he received his early education at the Thos. Fraser School in Golspie. Proceeding to the University of Edinburgh, he there received the degree of M. A. in 1871 and the M. B. and C. M. in 1873. Then for a number of months he studied at Vienna with Jaeger.

Returning to London, he became at the Royal London Ophthalmic

Hospital ("Moorfields") Junior House Surgeon in August, 1876, and Senior House Surgeon in the December following. In 1882 he became an F. R. C. S. (England), and in 1883 Assistant Surgeon, in 1888 Surgeon, to the Royal London Ophthalmic Hospital. Among his other hospital appointments were: Ophthalmic Surgeon to the National Hospital for the Paralysed and Epileptic, Ophthalmic Surgeon to the Hospital for Sick Children, and Assistant Ophthalmic Surgeon to the University College Hospital. From 1896 to 1899 he was Vice-President, and from 1907 to 1909 President, of the Ophthalmological Society of the United Kingdom.



Robert Marcus Gunn.

In 1898 he was Vice-Chairman of the Section of Ophthalmology of the British Medical Association, and, in 1906, at Toronto, Chairman of the same assemblage. He delivered a number of addresses on ophthalmologic subjects before various foreign ophthalmologic bodies, perhaps the most important being "On Certain Affections of the Optic Nerve" before the American Academy of Ophthalmology and Oto-Laryngology.

His original work in the field of human ophthalmology was almost wholly on the subject of the optic nerve, the retina, and the cornea; the anatomy, physiology, and diseases of these structures. His researches in comparative ophthalmology, especially comparative anatomy and histology, are very extensive and important.

Dr. Gunn died Nov. 29, 1909, leaving a wife and two daughters.

He will long be remembered not only by his friends, but by all who ever met him. Strongly marked in character, he could not be forgotten. Positive, aggressive, sometimes actually intolerant, rather inclined to enthusiasm when absolutely certain of his views, coolly skeptical on other occasions, sensitive to injustice, decidedly ready to

forgive, and (rarest of all the virtues) as ready to be forgiven. He was fond of outdoor recreation, shooting, hunting and the like, and, to the end of his days, was an ardent student in the open air of botany, zoology, geology and mineralogy.

He wrote no books, but published a number of articles, the chief of which are: 1. Peculiar Appearance of the Retina. ("Crick-dots," or "Gunn's dots," *R. L. O. H. Reports,* III.) 2. Amblyopia from Bisulphide of Carbon. (*T. O. S.,* Vol. VI.) 3. Uniocular Nystagmus. (*Ibid.,* Vol. VII.) 4. Toxic Amblyopia. (*Ibid.,* Vol. VII.) 5. Growth of New Lens-Fibres. (*Ibid.,* VIII and XV.) 6. Peculiar Foveal Reflex in Myopic Amblyopia. (*Ibid.,* Vol. VIII.) 7. Congenital Malformations of Eye. (*Ophthal. Review,* Vol. VIII, 2 Lectures, 1889.) 8. On Sympathetic Inflammation of the Eyeball. (*R. L. O. H. Reports,*, Vol. XI, pp. 78-102, and 273-326.) 9. Note on Certain Retinal Reflexes Visible with the Ophthalmoscope. (*Ibid.,* Vol. XII, 348.) 10. Light-Percipient Organs and Light and Color-Perception. (*Ibid.,* Vol. XII, p. 101.) 11. Ophthalmoscopic Evidence of Increased Arterial Tension, and of General Arterial Disease. (*T. O. S.,* Vols. XII, XVIII, and XXIV.) 12. Pemphigus of Conjunctiva. (*Ibid.,* Vols. XIII and XV.) 13. Hemorrhage into Optic Nerve Sheath. (*Ibid.,* Vol. XIV.) 14. Acute Bullous Eruption of Skin and Conjunctiva. (*Ibid.,* Vol. XVI.) 15. Retinitis Circinata. (*Ibid.,* Vol. XVIII.) 16. Bowman Lecture—Visual Sensations. (*Ibid.,* Vol. XX.) 17. Keratitis Nodosa, Family Case. (*Ibid.,* Vols. XXII and XXIX.) 18. Family Optic Atrophy. (*Ibid.,* Vol. XXVII.) 19. Presidential Address. (*Ibid.,* Vol. XXVIII.) 20. Hemorrhagic Disease of Retina, with Obliteration of Veins. (*Helmholtz Festschrift,* Plate II, 1891.) —(T. H. S.)

Gunning, Willem Marius. A Dutch ophthalmologist of considerable local reputation. Born at Hoorn, Holland, July 15, 1834, he received his medical degree at Utrecht, Sept. 11, 1857. For a time he was assistant physician at "Buiten-Gasthuis," but always, owing to the influence of Donders, under whom he had studied in the University, he desired to be an ophthalmologist. In accordance with this desire, he began about 1863 to devote himself to ophthalmology exclusively. In 1877 he was appointed full professor of ophthalmology at the Amsterdam University. He wrote a few articles and reports, but no books. He died in May, 1912.—(T. H. S.)

Gunpowder burn of the eye. This is one of the commonest of injuries, but owing to the crusade in this country against the reckless use of fireworks and firearms, especially during Fourth-of-July celebrations, they are not as frequent as formerly. See page 3232, Vol. V, of this

Encyclopedia. The *treatment* and additional information regarding gunpowder injuries will be found under **Injuries of the eye.**

R. H. Elliot (*Ophthalmology,* July, 1911) reports that during the closing months of each year a number of gunpowder wounds of the eyes are seen in India, due to the fact that at that time there are feasts at which explosives are used. The most common form of explosive is prepared by making a mixture of sulphide of arsenic and chlorate of potash. After this has been gently rubbed together by digital pressure it is mixed with gravel, carefully wrapped in paper and cloth and is exploded by concussion. After the mixture with gravel the danger of explosion is greatest and the eyes suffer most frequently. The mixture slowly dissolves in the tissues where it is lodged and produces a chemical irritation, followed by chronic irido-cyclitis, not infrequently culminating in loss of vision and even of the eye. It is very difficult to remove the granules and little can be done except the use of atropin and treatment along general lines.

Gun-searcher. An optical appliance for use in examining the bore of a gun.

Gunshot injuries of the ocular apparatus. This is an interesting and important subject which is treated under **Injuries of the eye,** as well as under **Military surgery of the eye.** Here attention may be drawn to some of the references furnished by a recent issue of the *Ophthalmic Year-Book.*

Oguchi (*Beiträge zur Augenheilk.,* Vol. 83, p. 75, 1913) gives a résumé of no fewer than 3,093 cases of *injuries of the eyes observed in the Russo-Japanese war.* Statistics concerning ocular injuries in late wars show that the number as well as the percentage of such were far higher during this war than in preceding ones. Most were caused by rifle shot; they occurred decidedly oftener in open battles than during attacks upon fortresses. Shot wounds affected both eyes with equal frequency, but stab wounds involved the left eye in 80 per cent. of the entire number; 515 enucleations and 94 exenterations were practised in all.

Shot injuries involved the globe, as a rule, by contusions; the reporter divides them into (1) direct crushing of the globe and the wall of the orbit; (2) indirect effects through the bony orbital wall with decided changes in the anterior segment of the globe; (3) grazing shots, especially of the lids; (4) distant effects in injury of other parts of the skull, and (5) double perforations.

The cornea was affected in the most varied manner; besides perforations, permanent opacities of the membrane were observed. Injuries of the sclera, iris and ciliary body were relatively frequent,

both as wounds and also as contusions. Sympathetic ophthalmia was very frequent. Choroidal ruptures were mostly due to shot injuries. This was uniformly the case in retinal disturbances (contusion and amotio). The reporter mentions especially the so-called retinitis traumatica, and opacity of the retina lasting for months. The optic nerve was wounded in a pretty large number of instances, without exception by shot. Injuries of the lens occurred particularly in attacks upon fortresses, especially through explosions. Contusion cataract from shot injury was rare. Injuries of the orbit, in 50 per cent. due to rifle shots, were generally accompanied by severe injuries of the brain, and were observed particularly in open battles. Disturbances of motility resulted from adhesions of the posterior segment to the surrounding parts, and from symblepharon. They were also due to lesions of the muscles or paralysis of the motor nerves.

In two cases of *bullet injuries of the orbit* seen by Lange (*Klin. Monatsbl. f. Augenheilk.*, p. 553, Nov., 1912) no permanent injury was done to the eyeballs or orbital structures.

In de Lapersonne's and Velter's (*Archives d'Ophtalm.*, Vol. 33, p. 193, 1913) case a boy of 14 was shot by a small caliber revolver bullet through the orbit directly from before backwards. The left eyeball was ruptured, the anterior portion protruding between the lids. There was also a voluminous hematoma of the left orbit. The right eye was normal. The X-rays showed the bullet in the left occipital lobe close to the median line, at a short distance from the posterior and superior wall of the cranium. The nervous system presented no focal symptoms. The general condition was very grave: marked torpor, slow pulse (65) but no rise in temperature. The following days the general condition became still graver; almost complete coma supervened with abolition of all the reflexes. The right papilla was markedly hyperemic. The fourth day lumbar puncture withdrew 25 cc. of bloody fluid. A second puncture two days later giving only a clear yellow liquid, was followed by progressive and definite amelioration. Nine days later the left eye was removed. The operation resulted in such marked improvement that the patient was out of bed in three days.

Examination made 16 days after the accident showed, first, very marked intellectual stupor with complete disorientation as to time and space; second, a considerable amnesia concerning all facts anterior to the accident, all the circumstances of the accident and even in regard to recent events; third, complex aphasic disturbances. There was not a trace of verbal deafness but a certain degree of verbal blindness and especially of physical blindness for words. There was no motor

aphasia but an aphasia from amnesia—a condition belonging to the group which has been described under the term visual verbal amnesia and more definitely *optic aphasia,* in which the motor image of the word is no longer evoked by the sight of the object, but where the evocation is possible if other sensory impressions (hearing) come to the aid of the visual impression. With the exception of these symptoms, the nervous system presented nothing abnormal. Rapid improvement took place; two and one-half months after the accident both the mental confusion and disorientation had disappeared; the amnesia of evocation still persisted, and there remained traces of literal blindness but for certain characters only.

The right eye, whose visual acuity was normal, showed a *quadrant hemianopsia* localized in the superior segment of the temporal visual field; there was also a slight contraction of the remaining field. Wernicke's hemianopic reaction could not be obtained.

The quadrant hemianopsia noted has been rarely recorded in traumatism of the cranium by firearms, for the reason perhaps that examination of the visual field is only possible in the fortunate cases in which recovery takes place. The psychic and aphasic disturbances present in this case have been frequently noted by various authors in more or less extensive alterations of the occipital lobe, especially in the region of the cuneus (hemorrhage, softening, tumors). Dide has proposed the term "occipital syndrome." This syndrome is very rare in traumatism by firearms. When it occurs in connection with hemianopsia, it may be taken to indicate a lesion of the posterior pole of the encephalon, but exact localization is very difficult. In the case reported, to judge from the radiograms, the track of the ball seems to have been quite high, above the isthmus of the encephalon, perhaps even above the optic thalamus, and to have affected the optic tracts only at the posterior and superior part of the left occipital lobe.

The writers raise the question whether in cases of traumatism of the orbit involving the globe by firearms, surgical intervention should be immediate or delayed. They incline to the view that delay is preferable, although opinions differ. They also discuss the point whether in the presence of grave general symptoms and particularly signs of intracranial hemorrhage which determine dangerous hypertension, lumbar puncture or trephining is to be practised. Here again they incline to the performance of the former unless an extensive wound or compression of bone call for immediate trephining.

In Hesse's (*Klin. M. f. Augenh.*, p. 29, July, 1913) case the patient was wounded by a small shot which entered the neck on the left side

about the junction of the upper and middle third of the sterno-cleido-mastoid near its posterior edge. A hemorrhagic exudate larger than a fist appeared. At the time of the traumatism a sharp sensation of light was experienced, apparently before the left eye, accompanied by temporary blindness of both eyes, but this quickly disappeared. Subsequently more exact observation by the patient himself showed that he was unable to distinguish objects to the right and downwards. The scotoma was very large in the beginning but had markedly improved in a few weeks. Besides severe headache upon the left side of the vertex and occipital region all other complaints were absent.

Examination four weeks later showed that the central visual acuity equalled 1.0. The visual fields of both eyes presented an almost perfectly symmetrical absolute *sectorform scotoma* extending from the fixation point about 30 degrees downward and outward toward the periphery; this was followed by a relative scotoma extending to the outer limits of the fields with diminished sensibility for white, but nowhere permitting a certain appreciation of colors.

Günz, Justus Gottfried. A well-known German surgeon, obstetrician, medico-historian and ophthalmologist. Born at Königstein, Germany, March 1, 1714, he received his training in the liberal arts at the gymnasium in Görlitz, and his medical education at the University of Leipsig from 1732-38. In 1747 he was appointed to the chair of physiology in his alma mater, and, a little later, to those of anatomy and surgery in the same institution. In 1751 he became official physician to the Elector of Saxony, but very soon afterward died.

According to Hirschberg, his ophthalmologic writings are as follows: 1. Diss. de Staphylomate, etc. (Leipsig, 1748.) 2. De Suffusionis Natura et Curatione. (Liepsig, 1748.) The first of these works, according to the same authority, is of very little value, while the second possesses a high degree of merit because of its clear and exact description of the cataract operation.—(T. H. S.)

Gürtelförmige Hornhautentzündung. (G.) Band-shaped keratitis.

Gürtelschicht des Thalamus. (G.) Stratum zonale of the optic thalamus.

Guthrie, Fred Ashford. A locally well-known ophthalmologist of La Salle, Illinois. Born at Aledo, Ill., Feb. 21, 1872, son of Noah H. and Delilah Guthrie, he received his general education at the University of Illinois and his medical training at the Rush Medical College, at which institution he received the degree in 1896. Forming a partnership with Dr. J. M. Wallace at Aledo, he practised for a time as general practitioner, but, afterwards studying ophthalmology and otolaryngology, he removed to La Salle, Ill., where he practised as specialist in those branches until his death.

He married in 1896 Miss Anna Laurena Oliver. To this union were born two children, John Oliver and Laurena Grace.

Dr. Guthrie died in the Presbyterian Hospital, Chicago, Feb. 28, 1915. He was a very pleasant and agreeable young man, of medium height, stout, smooth-faced, of fair, rosy complexion, and with bright blue eyes, and a brisk, gay, happy manner, which endeared him to all, patients and profession alike.—(T. H. S.)

Fred Ashford Guthrie.

Gutta. (L.) Drop. Effusion of a liquid drop by drop. The bathing of a part by dropping water on it.

Gutta opaca. (L.) A name given by the ancients to cataract, as they supposed it an opaque drop in front of the lens. See **Guy de Chauliac.**

Gutta serena. A name given by the ancients—probably original with the Arabians—to amaurosis, supposing it to depend on a clear drop fallen from the brain into the eye; the "drop serene" of Milton. See **Guy de Chauliac.**

Guttate iritis. See **Iritis, Guttate.**

Guttatim. (L.) By drops.

Gutter lens. A very rare congenital anomaly of the crystalline described by Otto Becker in 1883.

Guy de Chauliac (also called Guido). The greatest surgeon of the Middle Ages. He was born about 1300 at the village of Chauliac, or

Cauliaco, on the borders of Auvergne, France. Educated at Montpellier, Bologna, and Paris, he settled in Lyons, where he practised for a long time, and finally became physician-in-ordinary to three successive popes—Clement VI, Innocent VI, and Urban V at Avignon. He died in 1638.

Guido's greatest work is his "*Chirurgiæ Tractatus Septem, cum Antidotario*" or "*Collectorium Artis Chirurgicalis Medicinæ,*" better known, however, as "*Chirurgia Magna,*" because of another and smaller work by the same writer, entitled "*Chirurgia Parva.*" The "*Chirurgia Magna,*" a marvel of learning and of literary style, was *facile princeps* of all the works on surgery throughout Western Europe for many centuries.

De Chauliac's writings on ophthalmology, so far as extant, are comprised in the second part of the seventh division of his "*Chirurgia Magna.*" Opinions differ greatly as to the value of these 31 folio pages. Pansier declares them to be an "uninteresting compilation"; Hirschberg, on the contrary, says regarding them: "I find this treatise better than almost any other which the European Middle Ages have bequeathed to us in our special branch; at all events, it was, in its day, more practical and instructive." The truth, in this instance, is probably with Pansier, for little that is really original appears in the book. The following passage, however, on cataract and "gutta serena," is memorable, as exhibiting, in a style at once terse and clear, the medieval views on cataract and amaurosis: "Cataract is a cuticular blemish in the eye, in front of the pupil, which disturbs the sight. It consists of a foreign humor, which gradually descends into the eye, and hardens in consequence of the eye's coldness. Whether this humor collects between the cornea and the iris (as Jesus proves) or between the aqueous humor and the crystalline lens (as Galen pretends in the tenth book 'On the Use of the Parts') does not interest me just now. The first stage is called 'Illusion of the Sight;' the second, 'The Falling of the Water,' or, sometimes, 'Gutta;' the third, or last, stage, 'Cataract,' because it obstructs the visual power, as the sluice of the mill, and as the waterfall from the sky obstructs the sun."

Besides the general surgeries—*magna* and *parva*—Guido also wrote a purely ophthalmologic monograph, no longer extant, entitled "*Manner of Life for Cataract-Patients.*" Concerning the origin of this book there runs a story. John, King of Bohemia, finding that he was going blind, sent to France for an oculist. The unfortunate eye-doctor arrived, but, proving unable to cure the irritable monarch, he was sewn up in a sack and cast into a river. An Arabian oculist was next sent for. He also was unsuccessful, and would, no doubt, have suf-

fered a like fate with that of his Frankish confrere, but for the fact that he had been clever enough to arrange in advance for a "safe conduct." Then the king betook himself to Montpellier, there to consult the great de Chauliac. Guido, however, would not undertake the case. Instead, he wrote for his royal patient the little book in question—"*Manner of Life for Cataract-Patients.*" The king, however, does not seem to have been greatly cheered by the volume which his calamity had called forth, and, becoming shortly afterward stone blind, he purposely sought and soon found "the greater darkness still" in the battle of Crécy.—(T. H. S.)

Gymnastics, Ocular. Regular muscular exercise of the eye to overcome muscular insufficiency. This important subject will be considered under **Muscles, Ocular.** Here the Editor gives the following method of using prisms for the home exercise of the convergence and accommodation which he has for many years been prescribing:

1. There are necessary a small candle or gas flame, placed twenty feet distant on a level with the eyes, in a fairly dark room, and the squared prisms ordered from the optician. Assume that they are 10°, 5° and 3°.

2. Sit squarely, facing the light, with both eyes open and (when these are ordered) wearing the glasses that are used for seeing in the distance.

3. Hold the 10° prism in the right hand with the inner surface touching the eye lashes (or glasses if these are worn) and the thin edge touching the nose; rotate the prism slightly until two lights appear and are seen on the same level. Then attempt to fuse the two lights into one image as follows: Hold the left forefinger on a level between the eyes and the light, about ten inches in front of the nose, and while looking intently at the finger-tip slowly bring it nearer until within four or five inches of the nose. Then look up at the light, which should appear single; if not, go through the same movements again until able to see one light without the aid of the finger. When the two lights are in this way seen as one the prism should be held before the eye until ten is slowly counted. Then remove it for the same period.

4. These movements are to be repeated for two minutes over each eye three times a day until one light is easily seen the moment the prism is held before either eye. Continue the exercises with this prism for 3 days. Then use for three days more the next strongest, which is 13°, obtained by placing the thickest edges of 10° and 3° together. Put a small rubber band around them, to hold them in place, and pro-

ceed as with the single one. Next, use the 10° and 5° for three days and finally all three together for three days.

Caution.—Do not use the prisms more than four minutes at a sitting nor if their use causes pain or discomfort. Be sure that the two lights are on the same level before trying to fuse them. The main purpose of these maneuvers is not merely to overcome the highest prism or prisms possible, but to exercise the eye muscles with a prism whose double images can be readily overcome. During this period of exercise the patient should consult the oculist as often as directed that he may supervise the treatment of the case.

Gymnophthalmus. (L.) Having the eye uncovered; without true eyelids, especially in reptiles. The *Gymnophthalmata* of Forbes are *Medusæ,* in which the eye-specks at the margin of the disc are unprotected.

Gynocardia odorata. An East Indian plant the seeds of which yield chaulmoogra oil.

Gypseous cataract. An over-mature, degenerated capsular or capsulo-lenticular cataract; so called from its white appearance.

Gyral. Gyrant. Whirling; rotating.

Gyrate atrophy (of choroid and retina). See p. 2139, Vol. III, of this *Encyclopedia.*

Gyrational. Characterized by gyration, or a motion of revolution.

Gyroidal. Spiral or gyratory.

Gyrus, Angular. Angular convolution. This cerebral area has important optic relations. It is situated at the posterior portion of the inferior parietal lobule, and hooks about the superior temporal fissure. Its posterior half really forms part of the occipital lobe.